

Input/Output Unit (IOU)
Hardware Maintenance

MAINTENANCE

Guide

 / CYBER 960/962
Computer System

CYBER 960/962 Computer Systems

Input/Output Unit (IOU)

Maintenance Guide

This product is intended for use only as described in this document. Control Data cannot be responsible for the proper functioning of undescribed features and parameters.

Manual History

Manual released at Revision A in August 1988. This edition obsoletes all previous editions.

Revision	Change Order	Date	Reason for Change
A	-	09-23-88	Manual released.

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Equipment Supported in This Manual

This manual supports the following equipment at the series levels listed, assuming all field change orders (FCOs) against the equipment have been installed. Compare the list of FCOs in this table with the list in your equipment FCO log. If the two lists match, this manual accurately reflects your equipment.

Equipment	Series	FCOs	Comments
AT478-B	01	-	Released.
AT481-B	01	-	Released.
AT482-B	01	-	Released.
AT490-B	01	-	Released.
AT497-B	01	-	Released.
AT498-B	01	-	Released.
AT501-E	01	-	Released.
AT509-A	01	-	Released.
AT511-A	01	-	Released.
AT512-A	01	-	Released.
AT513-A	01	-	Released.
AT514-A	01	-	Released.

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About This Manual

The information in this manual supplements the other CDC® CYBER® 960/962 computer system manuals shown in the hardware manuals figure. Each of the two basic IOU types, AT478-B/AT481-B and AT511-A/AT512-A, used with the CYBER 960/962 systems is documented separately. This manual is organized as follows.

Chapter	Title
1	Introduction
2	AT478-B/AT481-B General
3	AT478-B/AT481-B Maintenance Aids
4	AT478-B/AT481-B Preventive Maintenance
5	AT478-B/AT481-B Corrective Maintenance
6	AT478-B/AT481-B Parts Data
7	AT511-A/AT512-A General
8	AT511-A/AT512-A Maintenance Aids
9	AT511-A/AT512-A Preventive Maintenance
10	AT511-A/AT512-A Corrective Maintenance
11	AT511-A/AT512-A Parts Data

The first chapter discusses briefly which IOUs are used with the 960 computer systems and shows the various optional configurations.

The maintenance aids chapters contain a tabulated list of the special tools, test equipment, and materials required to assist in maintenance of an IOU type.

Preventive maintenance contains information regarding tasks that, when performed on an unscheduled basis, tend to enhance the continued operation of an IOU type.

WARNING

The procedures in this manual were verified on the equipment under strictly controlled conditions. Any deviation from the procedures may result in personal injury or damage to the equipment.

Corrective maintenance contains removal and replacement procedures for those parts that are designated as field-replaceable units (FRUs), and that require special instruction during the procedure. This section also includes support procedures generally associated with maintenance activity: logic module cleaning, antistatic handling procedures, and so forth for an IOU type.

Parts data contains the list of FRUs and their part numbers for an IOU type.

The glossary (appendix A) contains descriptions of all acronyms used in the manual. It also defines any terms that might not be common knowledge to users of this manual.

Audience

This manual is for use by experienced field personnel who are familiar with Control Data computing systems and Control Data maintenance practices. The manual provides detailed maintenance information for the input/output units (IOUs) used with the CYBER 960 Series computer systems.

Conventions

New features, as well as technical changes, deletions, and additions to this manual, are indicated by vertical bars in the margins.

Disclaimer

This product is intended for use only as described in this document. Control Data cannot be responsible for the proper functioning of undescribed features and parameters.

Radio Frequency Warning

⚠ WARNING

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a class A computing device and peripheral computing devices pursuant to Subpart J of part 15 of the FCC Rules which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user, at his own expense, will be required to take whatever measures may be required to correct the interference.

Related Manuals

This and other related manuals are listed in the CYBER 960/962 Hardware Manuals set figure (shown on the following page).

CYBER 960/962 HARDWARE MANUALS

SYSTEM MANUALS

Site Preparation

General
Information
Site Preparation

60275100

Mainframe
Complex Data
Site Preparation

60000119

Peripheral
Equipment Data
Site Preparation

60275300

Installation

Mainframe
Installation and
Checkout

60000120

Operation

Virtual State
Reference

Volume 1

60000132

Virtual State
Reference

Volume 2

60000133

CYBER 170 State
Reference

60000127

19003 System
Console Operations/
Maintenance

60463610

Troubleshooting

System
Troubleshooting

60000122

Codes

System Codes
Booklet

60458100

EQUIPMENT MANUALS

Central Processing Unit (CPU)

CPU Maintenance

60000123

CPU Theory and
Diagrams

60000118

Mainframe Power and Environmental

Mainframe Power
and Environmental
Subsystem
Maintenance

60000125

Mainframe Power
and Environmental
Subsystem
Theory and
Diagrams

60000121

Input/Output Unit (IOU)

IOU Maintenance

60000130

CYBER 960 IOU Manuals

IOU Theory and
Diagrams

Levels 0-3

60463540

IOU Diagrams

Level 4

60462210

Wire Lists
Microfiche
60000134

CYBER 962 IOU Manuals

IOU Theory and
Diagrams

Levels 0-3

60000235

IOU Diagrams

Level 4

60000236

Wire Lists
Microfiche
60000135

Motor Generator (MG) Equipment

25-kVA Frequency
Converter
Hardware
Maintenance

60456520

40-kVA Control
Cabinet and Motor
Generator Hardware
Maintenance

60454720

MG Interface Unit
Installation and
Maintenance

60000124

M02240

Additional Related Manuals

The following manuals contain information that may be useful.

Manual Title	Publication Number
CYBER Initialization Package (CIP) Reference Manual	60457180
CML/VE Reference Manual	60000019
Concurrent Maintenance Library Reference Manual	60455980
Hardware Performance Analyzer (HPA) Reference Manual	60459460
HPA/VE Reference Manual	60461930
MSL 15X Off-Line Maintenance Software Library Reference Manual	60456530
MSL 153/155 Maintenance Software Reference Manual Test Descriptions	60461920
MSL 153/155 Maintenance Software Reference Manual Test Procedures	60461110

Submitting Comments

Control Data welcomes your comments about this manual. Your comments may include your opinion of the usefulness of this manual, your suggestions for specific improvements, and the reporting of any errors you have found.

You can submit your comments on the comment sheet on the last page of this manual. If the manual has no comment sheet, mail your comments to:

CONTROL DATA
Technical Publications
ARH219
4201 Lexington Avenue North
St. Paul, Minnesota 55126-6198

Please indicate whether you would like a written response.

Ordering Manuals

Control Data manuals are available through Control Data sales offices or through:

CONTROL DATA
Literature and Distribution services
308 North Dale Street
St. Paul, Minnesota 55103-2495

The latest manual revision levels and ordering information are in the Literature and Distribution Services Catalog, publication number 90310500.

Introduction

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This chapter identifies and shows the association of the input/output units (IOUs) that can be used by a CYBER 960 Series computer system (figure 1-1).

Equipment Covered by This Manual

This manual briefly describes and provides maintenance and parts information for an IOU used with CYBER 960/962 computer systems.

The following is a list of the standard and optional equipment that might be involved in configuring such an IOU.

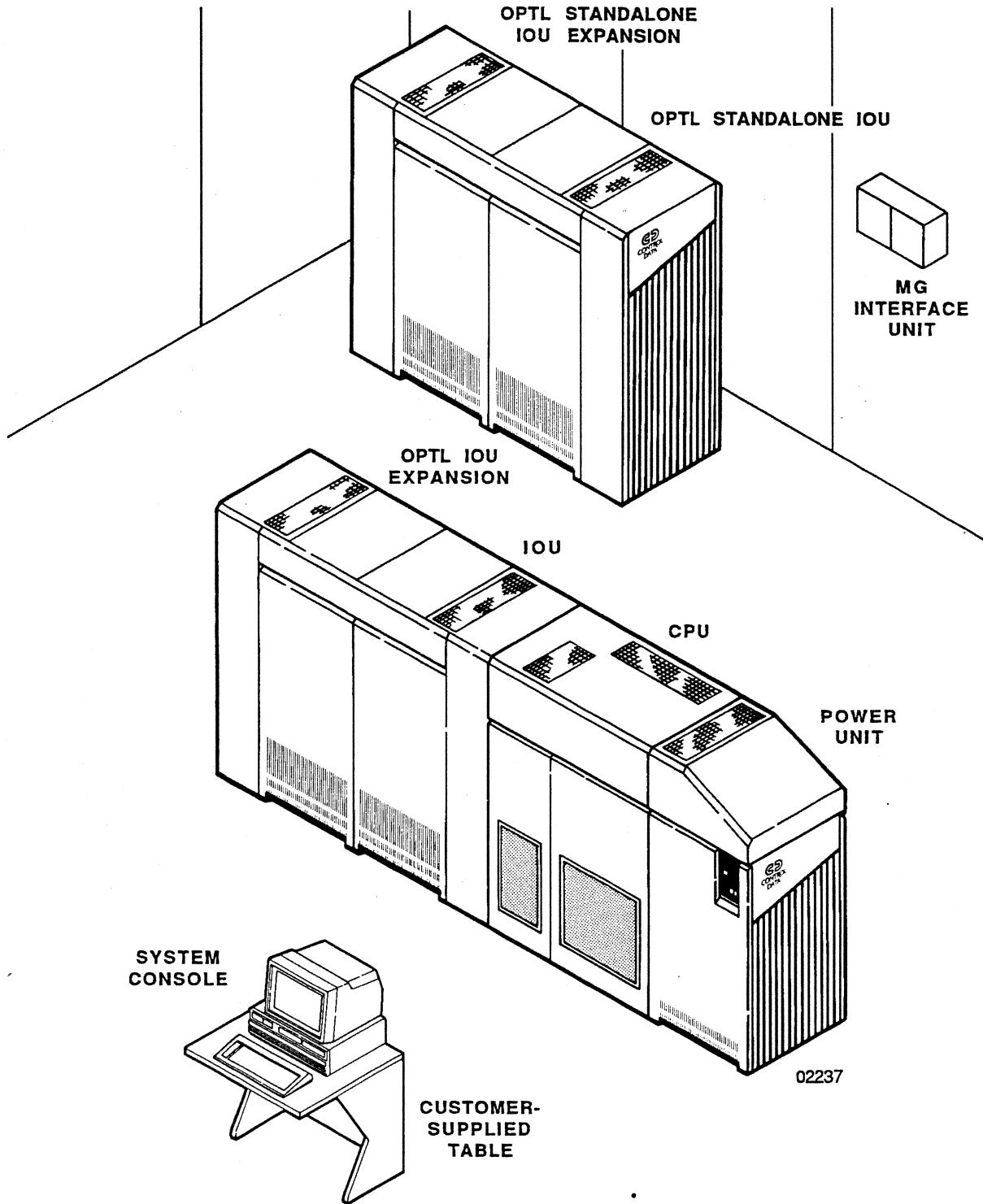
- AT478-B Nonconcurrent Input/Output (NIO) Unit
- AT481-B Concurrent Input/Output (CIO) Unit
- AT482-A Peripheral Processor (PP) Increment
- AT490-B Intelligent Standard Interface (ISI)/Direct Memory Access (DMA) Channel
- AT497-B Intelligent Peripheral Interface (IPI)/DMA Channel
- AT498-B CYBER 170/DMA Channel
- AT501-E Standalone IOU Conversion Kit
- AT509-A Interface Kit
- AT511-A CIO Unit
- AT512-A CIO Unit
- AT513-A PP Increment
- AT514-A Interface Kit

Figure 1-2 illustrates the standard and optional IOU equipment that might be encountered on a typical CYBER 960/962 computer system.

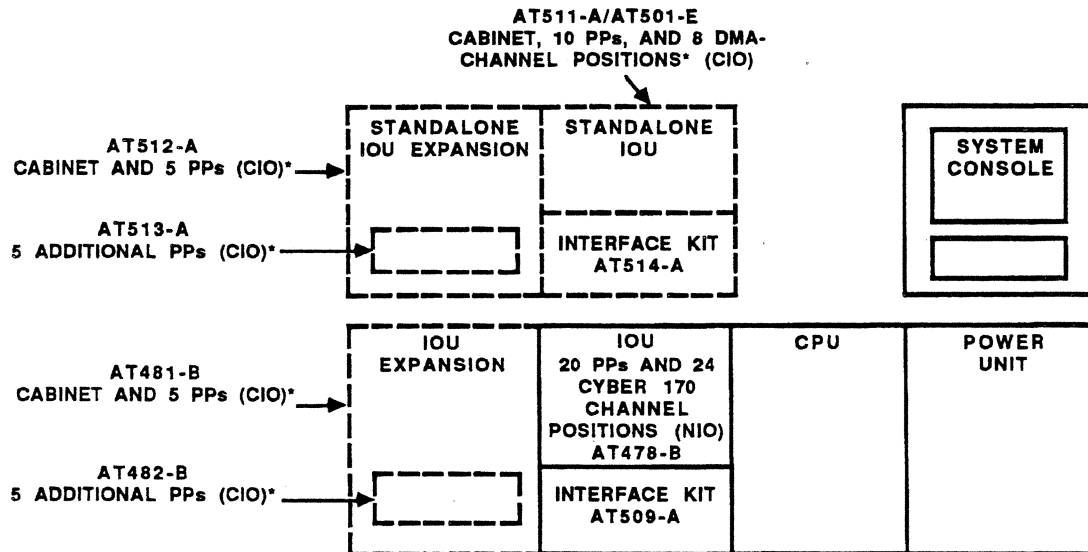
As shown on figure 1-2, a CYBER 960 computer system can contain two basic types of IOUs. These two basic types are the AT478-B/AT481-B type and the AT511-A/AT512-A type. The IOU types are different and are, for clarity, documented separately in this manual. Table 1-1 shows the differences between the two basic types.

The AT478-B/AT481-B IOU contains two subsystems: AT478-B NIO subsystem and AT481-B CIO subsystem. The AT478-B/AT481-B IOU can be used with systems running NOS, NOS/VE, or dual-state operating systems.

The AT511-A/AT512-A IOU is a CIO-only subsystem that can be used only in either a system running NOS/VE or for NOS/VE tasks in a dual-state operating system.



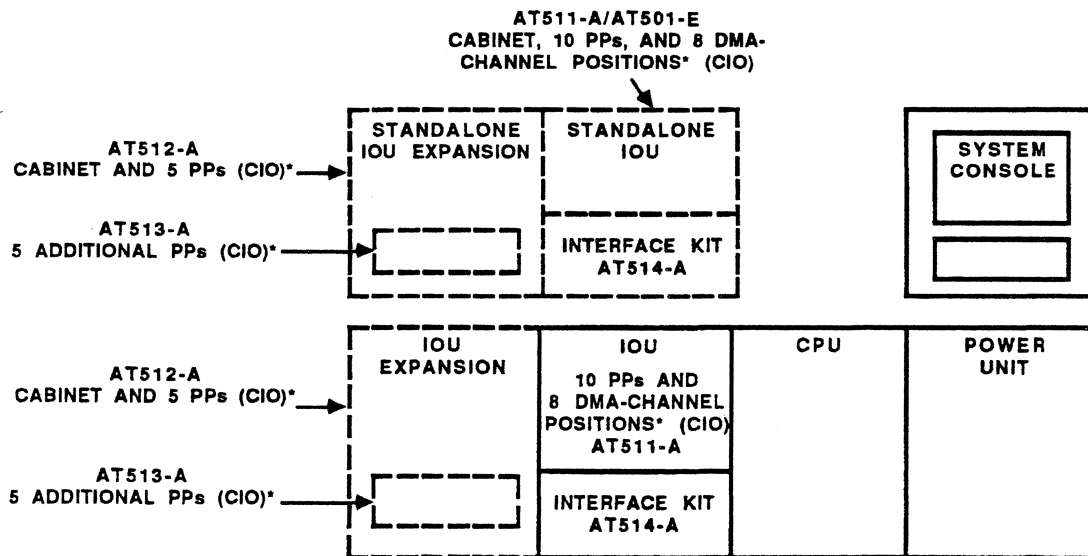
CYBER 960 SYSTEM IOU OPTIONS



* CHANNELS TO COMPLEMENT CIO PP_s OR DMA-CHANNEL POSITIONS ARE SELECTED BY CUSTOMER FROM THE FOLLOWING PRODUCT OPTIONS:

- AT490-B ISI/DMA CHANNEL
- AT498-B CYBER 170/DMA CHANNEL
- AT497-B IPI/DMA CHANNEL

CYBER 962 SYSTEM IOU OPTIONS



* CHANNELS TO COMPLEMENT CIO PP_s OR DMA-CHANNEL POSITIONS ARE SELECTED BY CUSTOMER FROM THE FOLLOWING PRODUCT OPTIONS:

- AT490-B ISI/DMA CHANNEL
- AT498-B CYBER 170/DMA CHANNEL
- AT497-B IPI/DMA CHANNEL

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Figure 1-2. CYBER 960/962 Computer System IOU Options

Table 1-1. IOU Basic Type Differences

Feature	AT478-B/AT481-B	AT511-A/AT512-A
Number of PPs	20 NIO and 5 or 10 CIO.	10, 15, or 20 CIO.
Number of channels	24 NIO 170-type and 5 or 10 CIO DMA-type.	Up to 18 DMA-type.
PP memory	4K or 8K by 16 bits selectable via maintenance register in NIO and 8K by 16 bits in CIO.	4K or 8K by 16 bits selectable via maintenance register in all PPs.
Reconfiguration	PP and barrel and slot reconfiguration supported.	Only PP reconfiguration supported.
Channel installation	CIO channel types for a barrel can be mixed, and must be installed in groups of five.	Channel types for a barrel can be mixed, and need not be installed in groups of five.
Direct memory access	CIO channels are DMA enhanced.	Channels 2 through 11 and 20 through 31 are DMA enhanced.
Channel types	NIO is all 170-type; CIO is CYBER 170/DMA, ISI/DMA, or IPI/DMA.	CYBER 170/DMA, ISI/DMA, or IPI/DMA.
Maintenance registers	Separate registers for NIO and CIO subsystems. Ten registers associated with the DMA enhanced channel adapters (0 through 9).	Only one set of maintenance registers. These can be accessed by either the AT511-A or the AT512-A register addresses. Ten registers associated with DMA enhanced channel adapters (0 through 9). Ten additional registers for additional DMA enhanced channel adapters, if present. Operating system boundary register bytes 2, 3, and 6; fault status 1 register bytes 2 and 3; and fault status 2 register byte 6 are read as all zeros if AT512-A is not installed.

(Continued)

Table 1-1. IOU Basic Type Differences *(Continued)*

Feature	AT478-B/AT481-B	AT511-A/AT512-A
IOU model number in element ID register	Hexadecimal 40.	Hexadecimal 44.
Display options	Supports CC598-B system console. Display station channel (DSC) on channel 10 for CC545.	Supports either CC598-A system console when functioning as primary IOU, or CC598-B system console when functioning as secondary IOU with an AT478-B/AT481-B as primary IOU. No DSC.

The AT478-B/AT481-B and AT511-A/AT512-A subsystems are the same relative to cabinetry, cooling, power, logic technology, and temperature protect/alarm system except as follows:

- AT478-B cabinet develops +5.0 V dc from a two-port multiplexer (TPM) power supply rather than a logic voltage bus; TPM (1JKH logic module) is the only logic module that requires the voltage.
- AT511-A cabinet does not contain a TPM control panel; TPM control functions are handled via CC598-B system console.

Purpose

The purpose of the IOU equipment is to provide an operational interface for the CYBER 960/962 Series computer systems that provides the following:

- Compatibility with a variety of peripheral devices equipped with either the CYBER 170 interface, the intelligent peripheral interface (IPI), or the intelligent standard interface (ISI).
- A modular design allowing the addition and/or change of interface type(s) as required.

Function

Three main functions are performed by the IOU equipment.

1. It transfers data between a peripheral device and the central processing unit (CPU) central memory (CM).
2. Once the IOU is initialized, it uses the system storage device to provide initialization programs and data for other elements of the system.
3. It provides access to maintenance registers in the CPU, the CM, and the IOU itself for use by the maintenance software.

Tools are also available to a customer engineer (CE) working from the system console that allow examination and, in some cases, alteration of the maintenance register content. Refer to the appropriate system hardware reference manual (refer to Related Manuals) for detailed descriptions of IOU operations, PP instructions, and other programming information.

Maintenance Philosophy

The maintenance philosophy for the CYBER 960 and 962 computer systems is as follows.

- Sites may or may not have an on-site CE.
- Preventive maintenance is unscheduled, and is to be performed by a CE as a part of a corrective maintenance visit to the site.
- If a system is down and the CE is absent, the customer immediately contacts the Customer Services Support Center (CSSC) for assistance. If (or when) the CE is present, the CE reviews the system dump, runs diagnostics to isolate the failure, and contacts CSSC. Contact is made with CSSC as follows:

U. S. and Canada 1-800-345-9904

International 612-851-4131

- Other general guidelines for handling a type of fault are as discussed in the following paragraphs.

Hung System

The system operator should respond to any system interrupt by dumping all memory and maintenance register contents to tape file prior to attempting a restart.

If the restart is successful, the CE and Technical Support analyze the dump to determine the cause of the interrupt.

If the restart is unsuccessful, the customer or the CE contacts the CSSC as discussed earlier.

System Degradation

Faults that are intermittent or do not take the system down, are normally reported via a hardware performance analyzer (HPA) type¹ report. When such a report is encountered, the CE schedules time with the customer to work on the problem.

The HPA-type report often indicates one or more possible field-replaceable units (FRUs). The CE uses the system troubleshooting guide to further isolate and repair the fault. If the fault cannot be duplicated, the CE replaces the FRU indicated by the HPA-type report, and returns the system to the customer.

1. NOS issues HPA reports and NOS/VE issues HPA/VE reports.

System Relationships

The functional relationships of the IOU interfaces and the IOU power system are discussed in the following paragraphs.

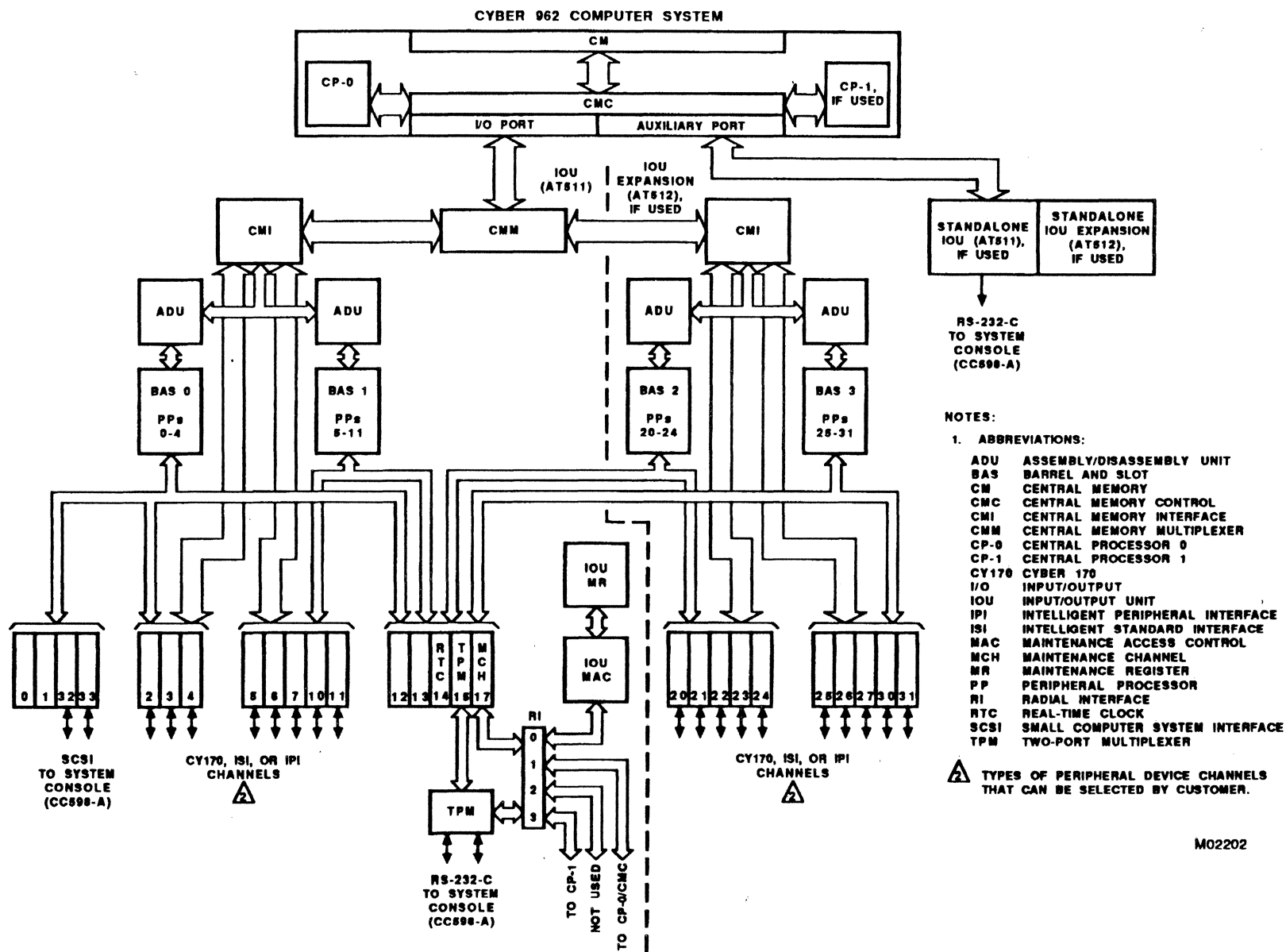
IOU Interfaces

Figures 1-3 and 1-4 depict the IOU's functional relationship within a CYBER 960 computer system and a CYBER 962 computer system, respectively. The figures also illustrate the relationship when an optional secondary IOU (standalone IOU and standalone IOU expansion) is present in the system.

The central memory control (CMC) sends a 40-ns and an 80-ns clock signal to the IOU, which is distributed to the CM logic.



Figure 1-4. IOU Relationships in a CYBER 962 Computer System



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IOU Power System

Figure 1-5 illustrates the relationship between the power system in an AT478-B/AT481-B type IOU cabinet and the CYBER 960 computer system in which it is installed. Figure 1-6 shows the relationship of an AT511-A/AT512-A type IOU cabinet to the CYBER 960 system of which it is a part.

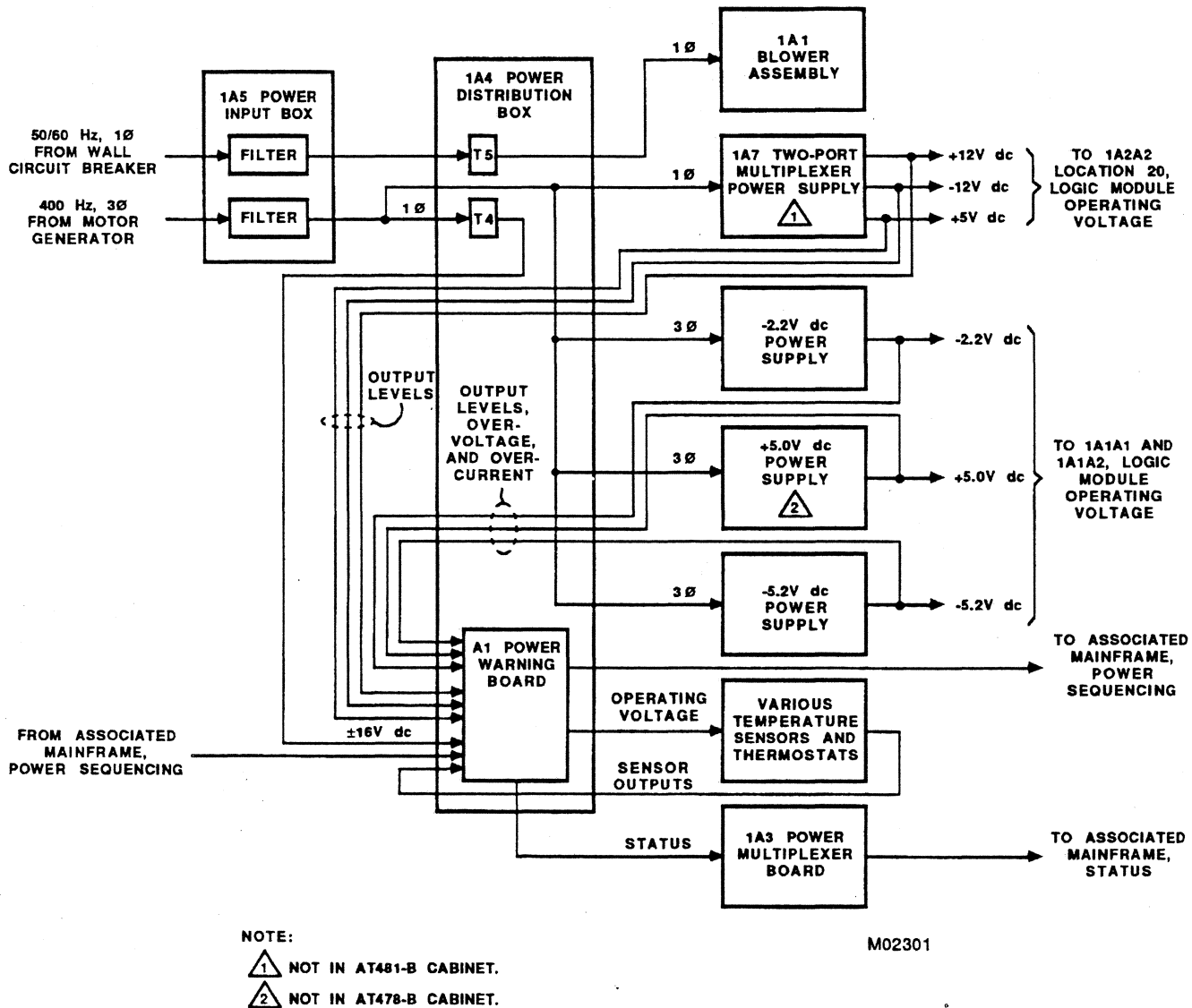


Figure 1-5. AT478-B/AT481-B Type Cabinet Power Block Diagram

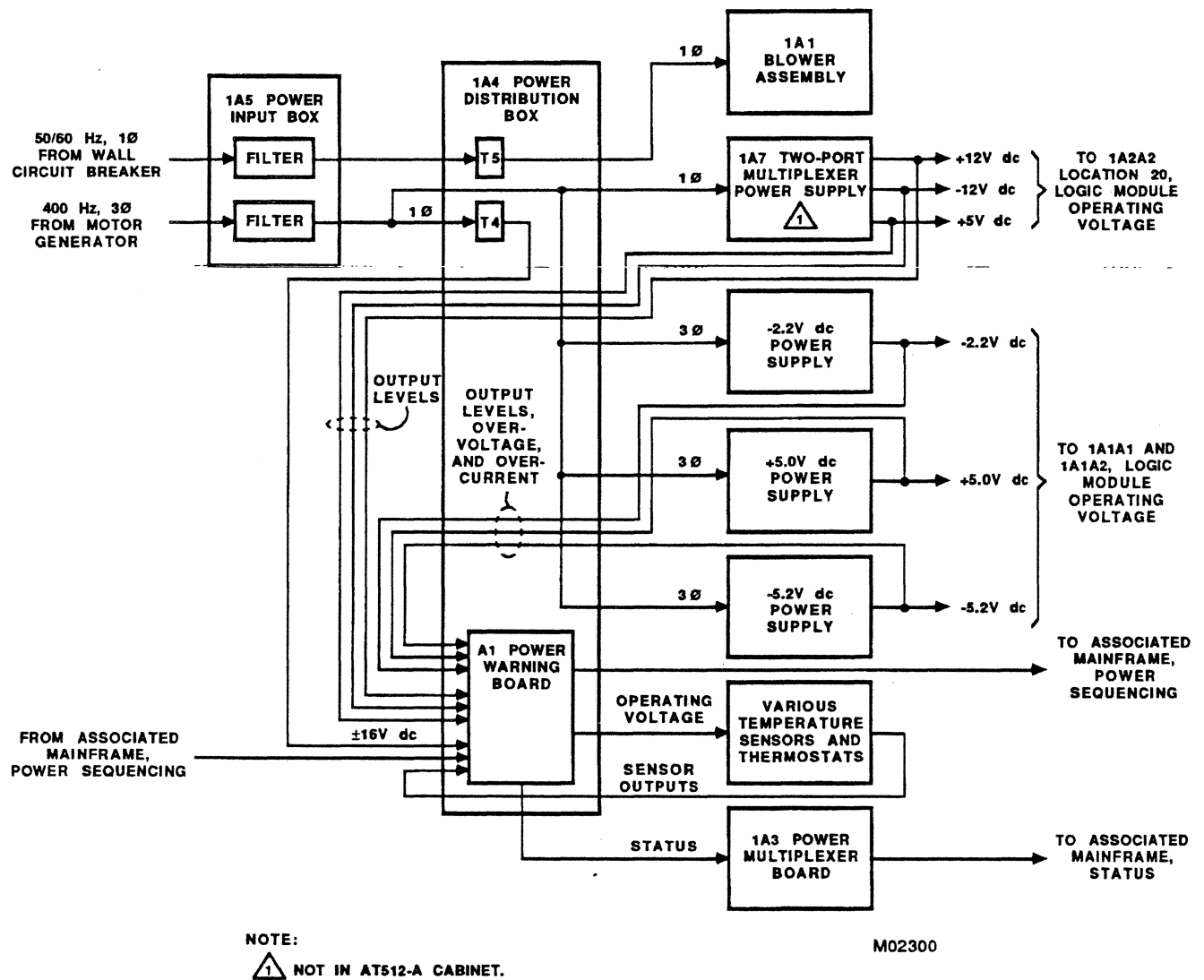


Figure 1-6. AT511-A/AT512-A Type Cabinet Power Block Diagram

Maintenance Features

The following paragraphs deal with the hardware and software maintenance features in the IOU cabinets.

Reliability and Maintainability Features

Reliability and maintainability are determined by the systems's ability to detect and, in some cases, correct errors, and to isolate faults. The features of the 960 and 962 computer systems are described in the following paragraphs.

Error Detection

An IOU subsystem uses the following methods to detect errors.

- Each major IOU data and address path, except for the A, P, Q, and R adders, is covered by parity checking.
- PP memory is covered by single-error-correction/double-error-detection (SECDED) with automatic hardware rewrite on single bit errors, and double bit errors detected but not corrected.
- The state of the central memory interface (CMI) and the assembly/disassembly unit (ADU) control logic is validated by comparing it with a predetermined state during known conditions.
- The maintenance channel and the ISI and IPI channel adapters contain timeout circuits to detect the lack of response from a given unit.

The master clock circuit detects the absence of the CM clock.

Error Logging and Containment

All detected errors are recorded in either a maintenance register or the associated DMA channel status registers. The logging of the error in these registers provides the operating system with ability to idle failing PPs and mask failing element errors, and provides a fault isolation capability.

Detected errors are not propagated except for CMI-detected output errors. These output errors cause the CMC to respond with an Uncorrected Response code, which decodes the failing PP.

Fault Isolation

There are two hardware elements in an IOU that possess an associated isolation method: fault status register and logic module light-emitting diode (LED).

Fault Status Register Method

The fault status register error isolation method requires interpreting the content of the fault status register, FS1 and FS2. This method is the more complex of the two methods, but it provides more information as to the possible causes. Refer to the system troubleshooting guide referenced under Related Manuals for the interpretation procedure and to either chapter 2 or 7 of this manual for the types of faults that are detected.

Logic Module LED Method

The logic module LED method makes use of the LEDs that exist on the outer edge of approximately 80 percent of the IOU's logic modules. These LEDs, when lighted, are easily visible through the transparent strip in the logic cage front cover.

An LED lights if the detection circuits of the logic module indicates the detection of an error. The LED remains lighted until a clear LED function is performed in the IOU maintenance access control (MAC). The LEDs point to the most probable cause of the failure, and can generally be used to quickly identify the logic module most likely at fault.

Certain procedures can cause LEDs to light when a fault does not actually exist. These sequences include:

- Powering up either an AT481-B CIO separately and after the companion AT478-B NIO, or an AT512-A CIO separately and after the companion AT511-A CIO. This can cause, either immediately or after operation by the AT481-B (or the AT512-A), one or more of the CIO's 1KBH logic module LEDs to light.
- Running CP or CM diagnostic tests that force errors as a part of the test.

If either one of these actions is performed, use the following procedure from the system console to deadstart and initialize the CIO before returning the CIO to normal operation.

Enter CTRL F2, select M option (maintenance), select I option (initialize), and select S option (short deadstart).

This sequence initializes the CIO and avoids the occurrence of false fault indications by the logic module LEDs.

Maintenance Channel

Channel 17 is the maintenance channel (MCH). The maintenance channel allows any PP to read and, in some cases, write maintenance registers in the CMI, in the associated computer system, and in the IOU itself. The maintenance channel is used by the maintenance software and can be accessed by various deadstart commands entered at the associated system console. Refer to the associated hardware reference manual listed under Related Manuals for more information.

Maintenance Software

The following paragraphs discuss the online and offline maintenance software available to the CE.

Online Maintenance Software

The type of on line maintenance software used by a system depends on the operating system running in the system: the Concurrent Maintenance Library (CML) for NOS or the Concurrent Maintenance Library/Virtual Environment (CML/VE) for NOS/VE.

Concurrent Maintenance Library (CML)

CML consists of three major types of diagnostics as follows:

- MALET (maintenance application language for equipment testing). A series of diagnostics that execute under the operating system to test peripheral devices connected to the system.
- Input/output confidence level tests (TIO). A test designed to provide a check of I/O operations and to assess the performance of the mass storage devices, tapes, and disks on the system.
- Microcode verification process. A process for comparing a suspected bad image of control store to a known good image.

The CML tape also includes the hardware performance analyzer (HPA). HPA is a program that maintains error information from detected hardware failures as reported by the operating system. For additional information, refer to the CML reference manual.

Concurrent Maintenance Library/Virtual Environment (CML/VE)

CML/VE provides interactive access to a set of menus that allows maintenance tasks to be performed by the following maintenance software products.

- MALET/VE (MALET for the virtual environment). A series of diagnostics that execute under the operating system to test peripherals connected to the system.
- HPA/VE (HPA for the virtual environment). A program that maintains error information from detected hardware failures and as reported by the system.
- DVS (diagnostic virtual system). A command utility that controls execution of on line diagnostic tests of the CP and CM.
- NPA (network performance analyzer). A command utility that constructs error and status reports for the CDCNET communications network.
- CDCNET Utility. A set of procedures to test, control, and display status of a CDCNET network.
- CML/VE utilities that allow observation and control of various maintenance aspects of the system's hardware configuration.

For additional information, refer to the CML/VE reference manual.

Offline Maintenance Software

Offline maintenance software for the system is referred to as the Maintenance Software Library (MSL) 15X. MSL 15X is a set of tests, diagnostics, and utilities that perform isolation of malfunctions, testing of system components, and monitoring of machine states. The MSL is divided into the following parts.

- CTI (common test and initialization) programs
- CMSE (common maintenance software executive) programs
- Interface routines
- Tests and diagnostics
- Utility routines
- Command buffers

These parts are included on a unique release tape, the CYBER Initialization Package (CIP), created for each model of computer system. Microcode, EI, CTI, SCD, MDD, CMSE, selected MSL programs, command buffers, and utility routines are distributed on the CIP tape to sites that have a maintenance contract. Sites without a maintenance contract receive a CIP tape that contains microcode, EI, CTI, CMSE, and a subset of MSL tests.

The MSL parts are described in the following paragraphs. Refer to the CML reference manual for detailed information.

Common Test and Initialization (CTI)

CTI performs hardware initialization and represents a standardized user interface to the deadstart process. CTI consists of a set of displays from which you can select the desired method for deadstarting. The CTI process includes some IOU testing and hardware initialization. The initial displays and options offered by CTI are described in the CIP reference manual.

Common Maintenance Software Executive (CMSE)

CMSE provides an offline monitor capability. Monitoring can be done from either a local or a remote console. CMSE also provides display facilities, a keyboard command structure, a loading capability, and diagnostic sequencing. CMSE can be initialized following a short deadstart, a long deadstart, or an extended deadstart.

Interface Routines

The MSL contains routines that interface between tests and utility programs.

Tests and Diagnostics

The MSL 15X library contains a set of tests for correct operation as well as diagnostics that isolate system faults. The MSL library is used as a source library for creating MSL binary tapes for each computer system model. The MSL 153, for example, is applicable to the CYBER series computer system. Descriptions of each test or diagnostic and the procedures for their use are provided in MSL 153/155 reference manuals.

Utility Routines

The utility routines provide features not available in standard tests. Two types of utilities exist: those that are part of CMSE, which are usually overlays and are executed by a CMSE command, and standalone utilities, which may require a supporting system to perform their function.

Command Buffers

Command buffers are useful tools enabling you to load and execute a series of tests and to set parameters. A command buffer is a series of keyboard (CMSE and program) commands residing on the MSL disk that are executed as a group by CMSE. Each command buffer is assigned a unique name to identify it on the disk. Command buffers may be read in from a card reader or entered interactively from a console. Refer to the MSL 15X Off-Line Maintenance Software Library Reference Manual for more detailed information.

AT478-B/AT481-B General Information

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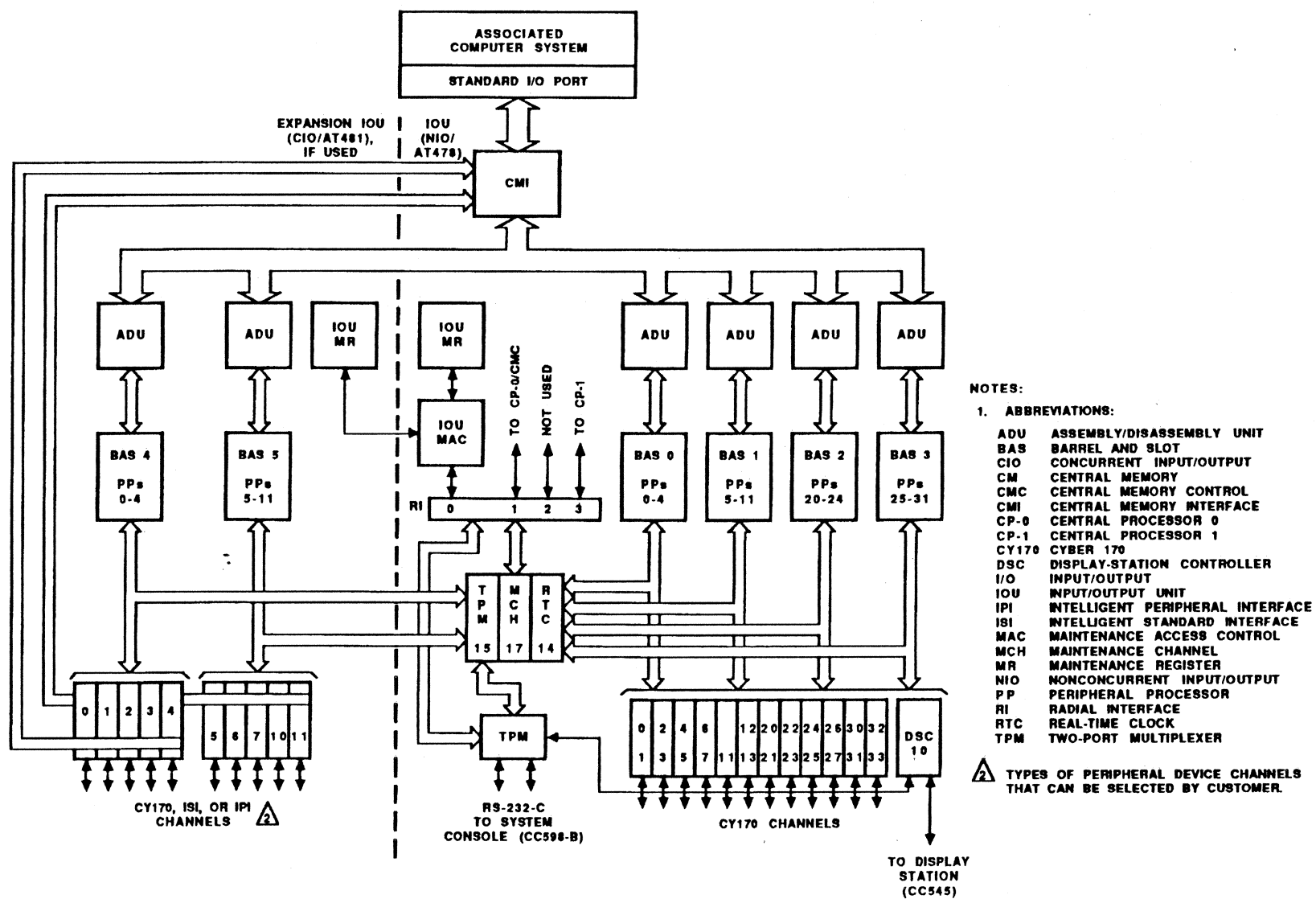
Each of the two cabinet types described in this chapter functions as a separate subsystem of the IOU system (figure 2-1) of which it is a part. The AT478-B nonconcurrent input/output (NIO) unit can function as an IOU by itself. However, the AT481-B concurrent input/output (CIO) unit can be used only in the presence of an NIO unit.

AT478-B NIO

The NIO consists of 20 peripheral processors (PPs). Each PP contains 8192 16-bit words of memory and a repertoire of 114 instructions. All PPs share access to a maximum of 24 input/output (I/O) channels. The PPs are partitioned into four barrels of five PPs, each of which allows the overall execution speed to be increased by a factor of four.

AT481-B CIO

The CIO consists of either five or 10 PPs that are partitioned into two barrels of five PPs. These PPs are identical to those used in the NIO. Each barrel of the CIO has a set of five direct memory access (DMA) I/O channels. These channel groups are dedicated to a barrel; no inter-barrel communications is possible. DMA refers to the capability of moving data between an I/O channel and central memory (CM) without using PP memory as an intermediate buffer. Concurrent DMA is implemented by enhancing the I/O channels in the CIO subsystem with a separate data path to the CM port. In a transfer of this type, the channel controls data flow thus allowing the PP to run concurrently.



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Configurations

The IOU system supports the following configuration extremes.

- Minimum configuration of 20 NIO PPs with 24 I/O channels.
- Maximum configuration of 20 NIO PPs with 24 I/O channels and 10 CIO PPs with 10 I/O channels.

Special channels are allocated for special functions as follows:

1. Channel 10, octal, is connected to the CC545 display controller. This channel is accessible only from the NIO subsystem.
2. Channel 14, octal, is connected to a real time clock (RTC). This channel is accessible by both the NIO and the CIO subsystems.
3. Channel 15, octal, is connected to the two-port multiplexer (TPM). This channel provides the serial interface needed to connect directly to a CC598-B system console. This channel is accessible by both the NIO and the CIO subsystems, and can be used for communication between subsystems.
4. Channel 17, octal, is connected to the maintenance channel (MCH) which includes seven radial interfaces. This channel is accessible by both the NIO and the CIO subsystems, and can be used for communication between subsystems.

Each element within the IOU system that can issue a CM request (PPs and DMA enhanced I/O channels) has its own set of assembly/disassembly unit (ADU) registers. An IOU system may interface with only one CM.

External Interfaces

The IOU has the following external interfaces.

NOTE

Channel and PP number designators are octal.

NIO Channels

In the NIO subsystem, any PP in any barrel may communicate with any other PP over any of the 24 I/O channels. The channels are numbered 0 through 13 and 20 through 33. Communications between PPs is always on a 16-bit boundary. The NIO subsystem supports CYBER 170 peripheral equipment (12 bits) using CYBER 170 logic modules (two channels per module). Special I/O instructions are provided to convert 12-bit channel words to 16-bit PP words and vice versa.

The CYBER 170 interface adapter provides an interface between the IOU and the CYBER 170 channel. This adapter supports a 3M bytes/s (standard CYBER 170) transfer rate.

CIO Channels

In the CIO subsystem, PPs within a barrel may communicate with any other PP in the same barrel on any of the five dedicated I/O channels. Communications between barrels or with the NIO subsystem must be done via channels 15 or 17. Communications between PPs is always on a 16-bit boundary. The channels are numbered 0 through 11. The CIO subsystem supports CYBER 170/DMA channels, intelligent standard interface (ISI)/DMA channels, and intelligent peripheral interface (IPI)/DMA channels.

The CYBER 170/DMA channel adapter provides an interface between the IOU and a CYBER 170 channel. This adapter supports two different transfer rates. They are a 3M bytes/s handshake (standard CYBER 170), and a 15M bytes/s burst (fast transfer mode). This adapter has three interfaces: a 12-bit plus parity bit for external interfaces, a 16-bit plus parity bit for the I/O channel bus, and a 64-bit plus eight parity bits for the DMA bus. The adapter contains control and status registers, assembly/disassembly registers, CM address and word count registers, and function decode logic.

The ISI/DMA channel adapter provides an interface between the IOU and an ISI. The maximum I/O transfer rate that can be achieved on this adapter is 12M bytes/s. This adapter has four interfaces: two 16-bit plus two parity bits for external interfaces, a 16-bit plus parity bit for the I/O channel bus, and a 64-bit plus eight parity bits for the DMA bus. The adapter contains control and status registers, assembly/disassembly registers, CM address and word count registers, and function code logic.

The IPI/DMA channel adapter provides an interface between the IOU and an IPI. The maximum I/O transfer rate that can be achieved on this adapter is 10M bytes/s. This adapter has four interfaces: two 16-bit plus two parity bits for external interfaces, a 16-bit plus parity bit for the I/O channel bus, and a 64-bit plus eight parity bits for the DMA bus. The adapter contains control and status registers, assembly/disassembly registers, CM address and word count registers, and function code logic.

Clocks

The CM or CMC of the associated computer system sends clocks to the IOU that are dependent on the computer system (refer to IOU Interfaces in chapter 1).

These clocks are connected to the IOU by two separate signal lines. The clocks are received on the master clock logic module (1JAH) and are distributed to the CM interface logic.

Maintenance Channel (MCH)

The maintenance channel is the interface between the IOU's maintenance registers and the associated computer system's processors, memories, and so forth. The IOU uses this channel to initialize the processor and memories. The IOU controls the operating environment and monitors the operating conditions of each of the computer system elements connected to the MCH. All I/O instructions can be executed on the MCH, and channel 17 is dedicated to the MCH.

The radial interface (RI) allows the maintenance access controllers of up to three mainframe elements to connect to the MCH. The RI is designed so that any connected element can be disconnected or shutdown without affecting the other elements.

Two-Port Multiplexer (TPM)

The TPM, located on the 1JKH logic module, is an asynchronous communications interface connected to channel 15. It contains two RS-232-C ports (port 0 and port 1) that can be used with the channel one at a time. Each port contains a 64-character buffer for receiving data from channel 15, and a three-character buffer for receiving data from the port to be sent to the channel. Each port has an associated eight-position BAUD RATE SELECTION switch and a four-position PORT OPTIONS switch (refer to Controls and Indicators).

The TPM supports a CC598-B system console. Ports 0 and 1 are both connected to the CC598-B. The system console is the principal device by which the operator interacts with the system. The TPM and the system console combine to deadstart the mainframe and/or the IOU and to perform utility functions for the various software systems: OS, CTI, CMSE, and so forth. The console is used to initiate the deadstart with a sequence that causes the TPM to recognize the system console as a legal deadstart device and to also allow an information exchange relative to any secondary IOU in the configuration. Once the system is running, the TPM acts as a pass-through device. The TPM and console communicate in a packet protocol when performing their utility functions for the software.

Central Memory Interface (CMI)

Each PP can read and write data to CM. The PP can read/write data from/to either a 60-bit CM word or a 64-bit CM word. Both modes are dynamically supported and mixed-mode is permitted. A 60-bit CM word is assembled/disassembled into four 16-bit PP words. Each of these words is written or read from successive locations in PP memory. Each DMA enhanced I/O channel can read and write data to CM.

The ISI and IPI channels support only 64-bit CM words. A 64-bit CM word is assembled/disassembled into four successive 16-bit channel words. The CYBER 170 channel supports both 60- and 64-bit CM words. In 60-bit mode, the channel uses five 12-bit channel words to form a 60-bit word. In 64-bit mode, sixteen 12-bit channel words are used to form three 64-bit CM words. Data, addresses, and control are resynchronized to and from the CM clock in the CMI.

The CMI connects to a standard port on the associated computer system. This interface runs on a CM clock which is asynchronous to the IOU. The CMI logic in the IOU provides the resynchronization. This interface supports a bandwidth of up to one 64-bit word every 64 ns (125M bytes/s).

Performance Monitoring

There are no special facilities in the IOU to monitor or record activity for the express purpose of performance monitoring. All performance monitoring is done with the aid of external hardware. The IOU provides test points on signals of interest for the purpose of performance monitoring.

IOU Components

The following paragraphs describe the major components of the IOU.

Central Memory Interface (CMI)

The CMI controls all CM requests. The three inputs to the CMI are from the six ADUs, DMA channels 0 through 4, and DMA channels 5 through 11. The data transfer to and from the CMI is 64-bit data words with eight parity bits.

The CMI also handles the resynchronization of all data and control signals between the internal 50-ns clock system and the external 64-ns clock system.

The CMI can hold up to eight requests for the ADU bus and up to 16 requests from each DMA channel bus. The CMI can accept simultaneous requests from all three units every internal clock cycle. It is the requesting unit's responsibility to regulate the number of requests out to the CMI. The CMI is capable of sending a request to CM every external clock cycle.

The CMI handles all requests in the same manner whether it is a read request or a write request. Whenever the CMI receives a valid request, the corresponding output buffer is written with whatever information is on the bus lines. This information is then sent to the CM when the request is honored. Whenever the CMI receives a valid response, the corresponding input buffer is written with whatever information is on line from the CM. This information is then sent to the requesting unit at the appropriate time, except during a DMA channel write operation when this information from CM is not gated to the DMA channel bus.

PP Memories (PPM)

Each peripheral processor has 8192 words (22 bits/word, of which 16 are data bits and 6 are SECDED bits) of memory. Normal operation for NIO PPs uses only 4096 words. Memories are organized into a three-bank system that allows data to be rewritten and corrected during a read. Memory addresses are 16 bits in length and only 13 bits are used. All memories are 16K by 1 bit read/write RAMs. Bank 0 contains the memories for PPs 0 and 3, bank 1 is the memory for PPs 1 and 4, and bank 2 is the memory for PP 2.

Control

Instruction decode and execution control is provided by firmware stored in PROMs. The I-barrel holds the PROM address for the next micrand. The I-barrel has 9 bits of data and 1 parity bit.

Assembly/Disassembly Unit (ADU)

The ADU is used during a write operation to assemble 12/16-bit PP memory words into a 60/64-bit CM word, and during a read operation to disassemble a 60/64-bit CM word into 12/16-bit PP memory words.

The ADU consists of six barrels, each barrel has its own assembly register and disassembly register and handles data from five PPs.

Data is transferred between the ADU and the barrel and slot via 16 data lines and one parity line per barrel. Data is bused between the ADU and the CMI via 64 data lines and 8 parity lines per barrel.

Maintenance Access Control (MAC)

The MAC provides access to the various IOU maintenance registers for the PPs and TPM microprocessor. The MAC is essentially an intelligent, multiple-way data multiplexer under nanocode control. In addition to providing access to the IOU maintenance registers, the MAC also translates functions from the PPs or the TPM microprocessor to perform ADU/CMI Master Clear, IOU Clear Errors, and Clear LEDs.

Maintenance Registers (MR)

The 28 maintenance registers (10 in NIO and 18 in CIO) provide the means of indicating fault status in the IOU and environs. The fault status indications for the IOU are done by associating failures with a particular logic module rather than a logical unit. Features to test the fault-sensing hardware are provided. Other tools are provided to assist diagnostic and operating system software in IOU identification, fault detection, and error recovery.

NIO Channels

The NIO subsystem contains 24 channel locations. Each channel location occupies one-half of a logic module location and is wired to an I/O channel bus. The I/O channel bus is used to communicate between the channel and a PP. The NIO subsystem can house only the CYBER 170 interface adapter.

CIO Channels

The CIO subsystem contains a maximum of 10 channel locations. Each channel location is three logic module locations wide, and is wired to an I/O channel bus and a DMA bus. The I/O channel bus is used to communicate between the channel and a PP. The DMA bus is used to communicate between the channel and CM. Each channel location can house one of three types of channel adapters. The three types are the CYBER 170/DMA channel adapter, the ISI/DMA channel adapter, and the IPI/DMA channel adapter.

Two-Port Multiplexer (TPM)

The TPM supports data communication using ASCII code. Special features supported by TPM when operating with CC598-B system console in either single or dual IOU mode.

- Autoanswer
- Remote deadstart
- Calendar clock
- Retrievable copies of pre-deadstart P, K, Q, and A registers
- Retrievable copies of pre-deadstart channel status
- Retrievable copies of pre-deadstart environmental control registers
- Retrievable copies of pre-deadstart fault status mask registers
- Alternate IOU configuration information
- Alternate IOU environment control registers
- Alternate IOU options installed registers

CC545 Display Controller (DSC)

The DSC provides communication capability between a PP and the CC545 display station.

The DSC can control one CC545 single-tube display station. The DSC generates displays in either dot mode (graphic displays) or character mode (alphanumeric displays).

The DSC supports all CYBER 170 12-bit function codes and the CYBER 170 display code character set. The DSC is capable of accepting 16-bit data (two ASCII characters). All unused characters are displayed as blanks. In keyboard input mode the controller is capable of translating the input character into ASCII code if ASCII code is selected.

Real Time Clock (RTC)

The RTC is 12 bits wide, and is a free-running counter that is incremented every μs . The RTC is read through channel 14 and is accessible by either the NIO or the CIO subsystem. Channel 14 is always active and full.

Cabinet Cooling

An IOU cabinet is air cooled by the cabinet elements shown in figure 2-2. Air to cool power supply components is drawn into the rear of the cabinet and into the two ends of the U-shaped heat sink assembly. The heat sink assembly and the heat sink weldment are the major points of heat dissipation from the cabinet power supply components mounted on these sinks. From the heat sink assembly, the air enters the heat sink weldment and the vertical heat duct. Upon leaving the vertical heat duct, the air enters the portion of the cabinet blower chamber containing the blower assembly. The air is then blown into the baffled portion of the cabinet blower chamber, and is exhausted vertically through the grillwork in the top of the chamber.

Air to cool logic modules in the logic cage is drawn into the front of the cabinet, through the filter (washable) in the bottom of the logic cage, and upward between the logic modules into the portion of the cabinet blower chamber containing the blower assembly. The air is then blown into the baffled chamber of the cabinet blower chamber, and is exhausted vertically through the grillwork in the top of the chamber.

Cooling is monitored by the following thermostats and temperature sensors.

- Temperature sensors 1TS1, 1TS2, and 1TS3 on the heat sink assembly.
- Thermostats 1S1 and 1S2 on the heat sink assembly.
- Temperature sensor 1TS4 below the bottom right-hand corner of the logic cage.
- Temperature sensor 1A1A1A1 and thermostat 1A1A1A2 in the blower assembly chamber sensing the output of the blower.

These devices monitor and initiate activity as shown in table 2-1.

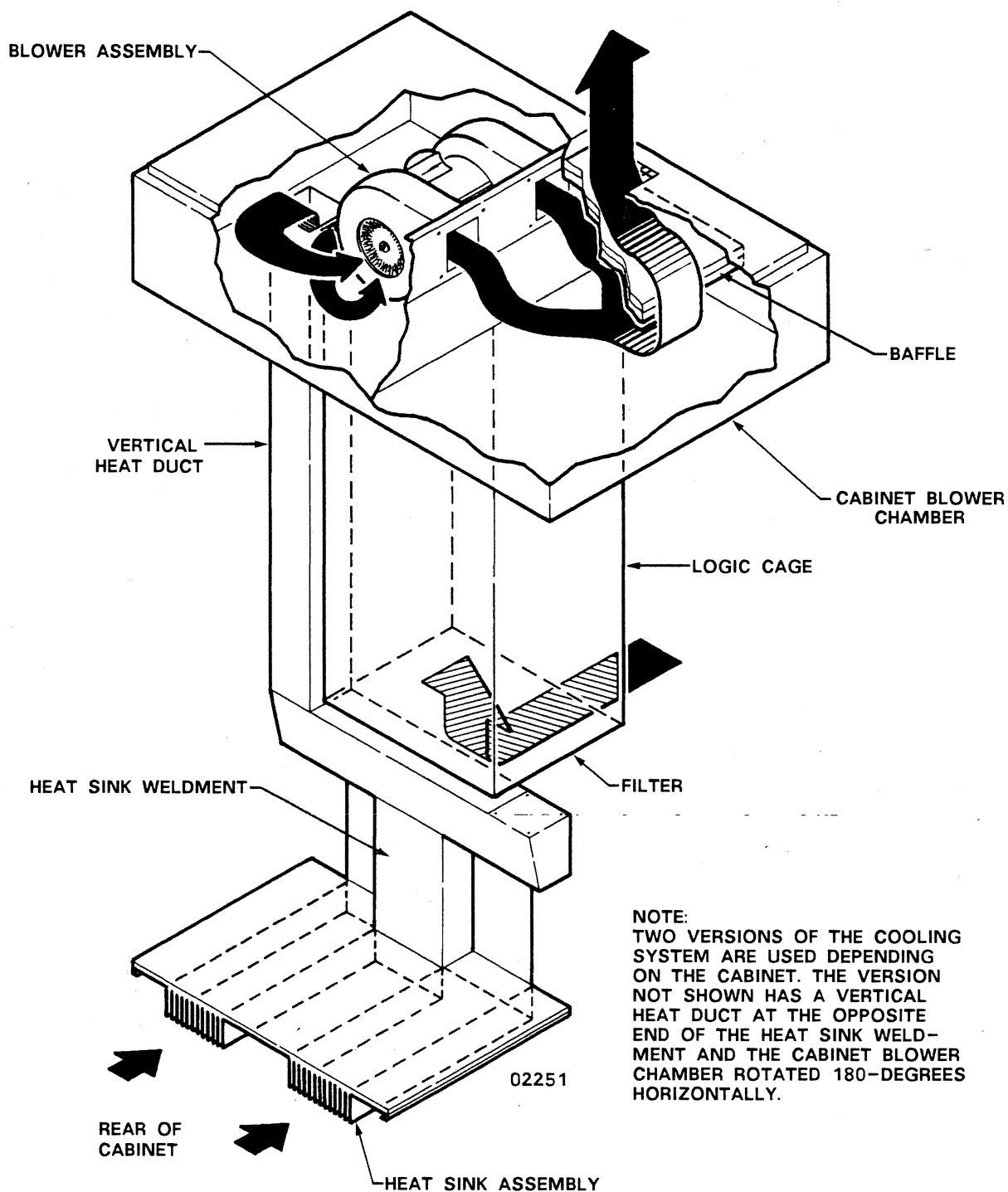


Figure 2-2. IOU Cabinet Air Cooling

Table 2-1. Cabinet Cooling Monitoring Devices

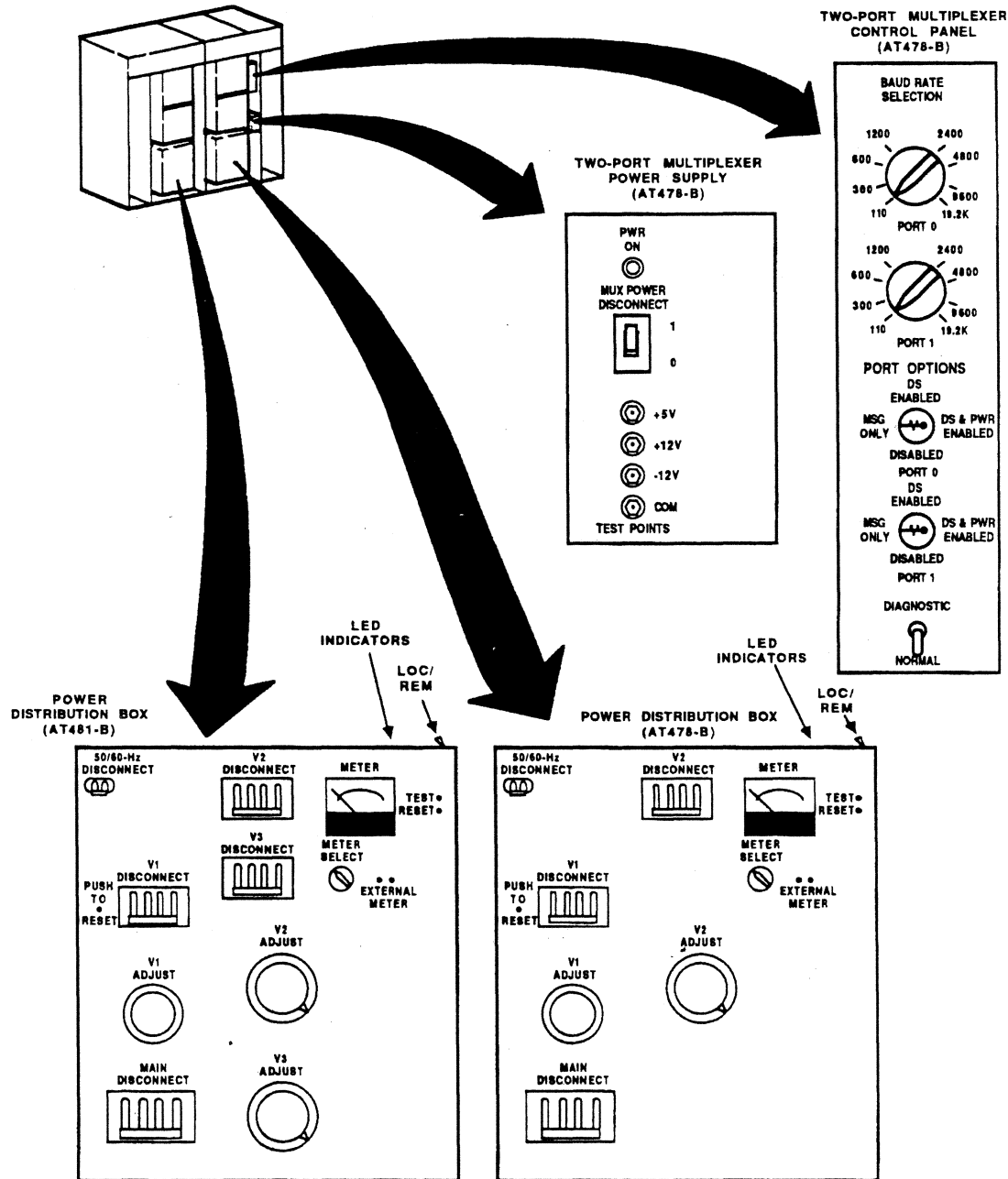
Device	Function	Signal Sent To¹	Action Initiated
1TS1 Temperature Sensor	Provides heat sink temperature, in degrees Fahrenheit.	1A4A1	None.
1TS2 Temperature Sensor	Provides temperature protection for V1 and V2 power diodes on heat sink.	1A4A1	Lights HEAT SINK HIGH TEMP LED at a heat sink temperature of 82°C (180°F), signals computer, and after 1 minute removes power to IOU cabinet. Initiates Long Warning.
1TS3 Temperature Sensor	Provides temperature protection for V2 and V3 (not used on AT478-B) power diodes on heat sink.	1A4A1	Lights HEAT SINK HIGH TEMP LED at a heat sink temperature of 82°C (180°F), signals computer, and after 1 minute removes power to IOU cabinet. Initiates Long Warning.
1TS4 Temperature Sensor	Provides logic cage input air temperature, in degrees Fahrenheit.	1A4A1	None.
1S1 Thermostat	Provides a backup signal for 1TS2.	1A4A1	Lights BACKUP LED at a heat sink temperature of 82°C (180°F) and immediately removes IOU cabinet power.
1S2 Thermostat	Provides a backup signal for 1TS3.	1A4A1	Lights BACKUP LED at a heat sink temperature of 82°C (180°F) and immediately removes IOU cabinet power.
1A1A1A1 Temperature Sensor	Provides blower assembly output air temperature, in degrees Fahrenheit.	1A4A1	None.
1A1A1A2 Temperature Sensor	Provides temperature protection for IOU power system and logic modules.	1A4A1	Lights BLOWER FAULT LED when blower exhaust reaches 65.6°C (150°F), signals computer, and after 1 minute removes power to IOU cabinet. Initiates Long Warning.

Note:

1. 1A4A1 is power warning board in power distribution box.

Controls and Indicators

Figure 2-3 illustrates the controls and indicators on the input/output unit cabinets. In addition to the panel controls and indicators, the majority of the logic modules each contain a light emitting diode (LED). These LEDs and each of the panels shown in figure 2-3 are described in a following paragraph.



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Figure 2-3. IOU Controls and Indicators

Logic Module LEDs

Approximately 80 percent of the IOU logic modules have an LED on their outer edge that when lighted is easily visible through the transparent strips in the logic cage front covers. An LED lights when that logic module detects an error. The LED remains lit until a Clear LED function is performed in the IOU's MAC. Any one of the following conditions in an AT478-B or an AT481-B will light an LED.

- Conversion error
- Operating system bounds parity error
- Firmware error
- Register barrel data parity error
- Response code parity error
- Uncorrected read response
- Uncorrected write response
- PP memory read double SECEDED error
- PP memory address parity error
- PP memory write parity error
- Y-multiplexer input data parity error
- CM reject
- CM data in error
- CM data out error
- Address function out error
- CM tag in error (AT478-B)
- CM tag out error (AT478-B)
- Channel error (AT478-B)
- MAC error (AT478-B)
- Radial interface error (AT478-B)

Any of the following conditions in an AT481-B containing CYBER 170/DMA or ISI/DMA channels will light an LED.

- Uncorrected CM error
- Invalid CM response
- CMI read data parity error
- Test mode error/clock fault
- Overflow error
- Input error
- Timeout/12 - 16 conversion error
- JY (1JYH logic module) data error
- BAS parity error

Any of the following conditions in an AT481-B containing IPI/DMA channels will light an LED.

- Illegal function
- Uncorrected CM error
- CM reject
- Invalid CM response
- CM response code parity error
- CMI read data parity error
- DMA register parity error
- MAC status parity error
- Timeout
- JY (1JYH logic module) data error
- BAS parity error
- Buffer counter parity error

- Sync counter parity error
- Period counter parity error
- Function upper parity error
- Function lower parity error
- Lost data
- Upper data parity error
- Lower data parity error
- IPI sequence error
- Bus A parity error
- Bus B parity error
- Illegal operation

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Power Distribution Panel

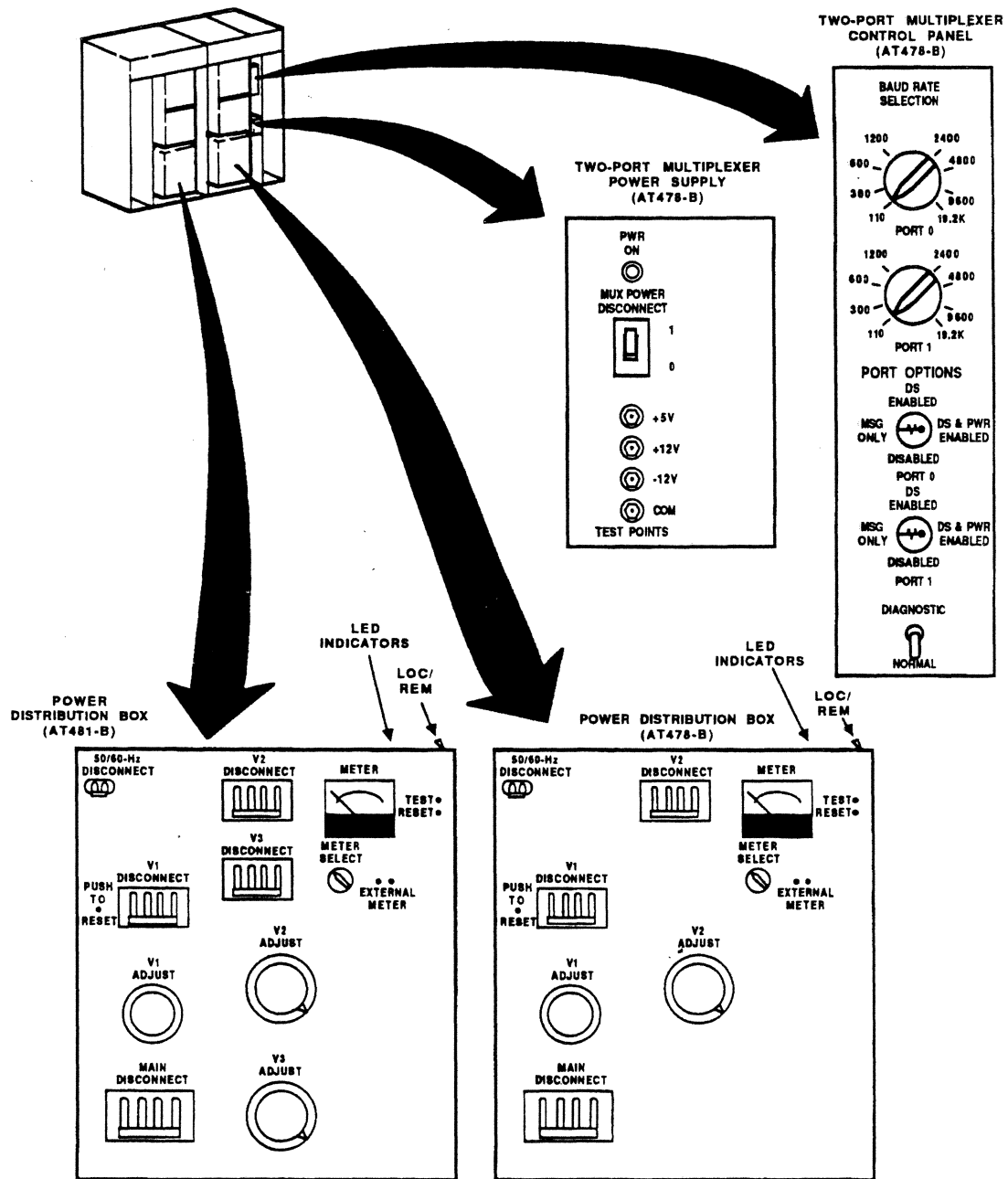
Tables 2-2 and 2-3 describe the function of the controls and indicators on the IOU power distribution panel.

Table 2-2. Power Distribution Box Switches and Circuit Breakers

Device	Panel Nomenclature	Function
Switches		
A4A1S1	LOC/REM	LOC - Specifies that cabinet power-up operation is independent of system except for Long Warning. REM - Specifies that cabinet requires a signal from a remote source in order to power up.
A4A1S2	RESET	Clears all latched faults in power control board.
A4A1S3	TEST	Simulates transient fault condition that trips Vx ¹ DISCONNECT breakers, lights Vx ¹ FAULT indicators, and warns system.
A4S1	METER SELECT	Connects meter, M1, to V1, V2, or V3 bus.
Circuit Breakers		
A4CB1	V1 DISCONNECT	Controls application of 400-Hz, 3-phase power to power transformer 1T1.
A4CB2	V2 DISCONNECT	Controls application of 400-Hz, 3-phase power to power transformer 1T2.
A4CB3	V3 DISCONNECT	Controls application of 400-Hz, 3-phase power to power transformer 1T3.
A4CB4	MAIN DISCONNECT	Controls application of 400-Hz, 3-phase power within power distribution box and (on AT478-B) to TPM power supply.
A4CB5	PUSH TO RESET	Provides cabinet reset capability for 400-Hz, 1-phase voltage to relays A4K3 and A4K4, and transformer A4T4 in power distribution box.
A4CB6	50/60 Hz DISCONNECT	Controls application of either 50-Hz or 60-Hz, 1-phase voltage to transformer A4T5.

Note:

1. V1 is -2.2 V dc, V2 is -5.2 V dc, and V3 is +5.0 V dc (see NOMINAL VOLTAGE label on panel). AT478-B does not contain V3 bus or any associated controls/indicators.

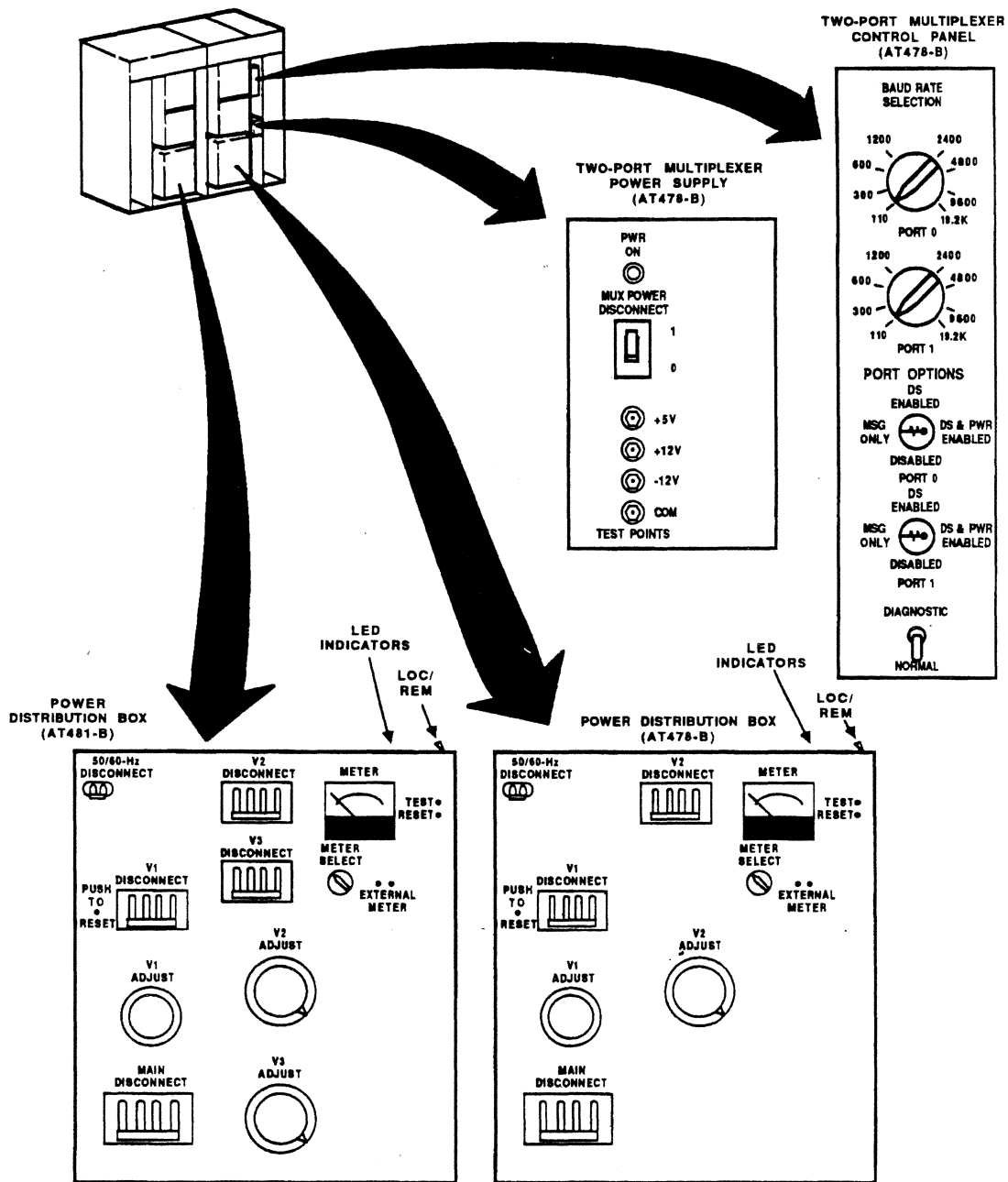


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Figure 2-4. IOU Controls and Indicators

Table 2-3. Power Distribution Box Test Points, Autotransformers, and Indicators

Device	Panel Nomenclature	Function
Test Points		
A4TP1, A4TP2	EXTERNAL METER	Power distribution box front panel measurement points for bus voltage currently selected by METER SELECT switch.
Autotransformers		
A4T1	V1 ADJUST	Adjusts level of 400-Hz, 3-phase voltage applied to power transformer 1T1.
A4T2	V2 ADJUST	Adjusts level of 400-Hz, 3-phase voltage applied to power transformer 1T3.
A4T3	V3 ADJUST	Adjusts level of 400-Hz, 3-phase voltage applied to power transformer 1T2.
Indicators		
LED1	BLOWER FAULT	Monitors airflow sensor output in 1A1 blower assembly. Lights if blower stops.
LED2	BACKUP	Indicates that thermostat 1S1 or 1S2 has sensed an out-of-tolerance temperature at power heat sink.
LED3	CIRCUIT BREAKER OFF/TRIP	Lights to indicate that circuit breaker A4CB1, A4CB2, or A4CB3 is off.
LED4	HEAT SINK HIGH TEMP	Indicates that temperature sensor 1TS2 or 1TS3 has sensed an out-of-tolerance temperature at power heat sink.
LED5	V3 FAULT	Lights if V3 bus voltage is out of tolerance.
LED6	V1 FAULT	Lights if V1 bus voltage is out of tolerance.
LED7	V2 FAULT	Lights if V2 bus voltage is out of tolerance.
LED8	POWER ON	Lights when relay A4K3 activated.



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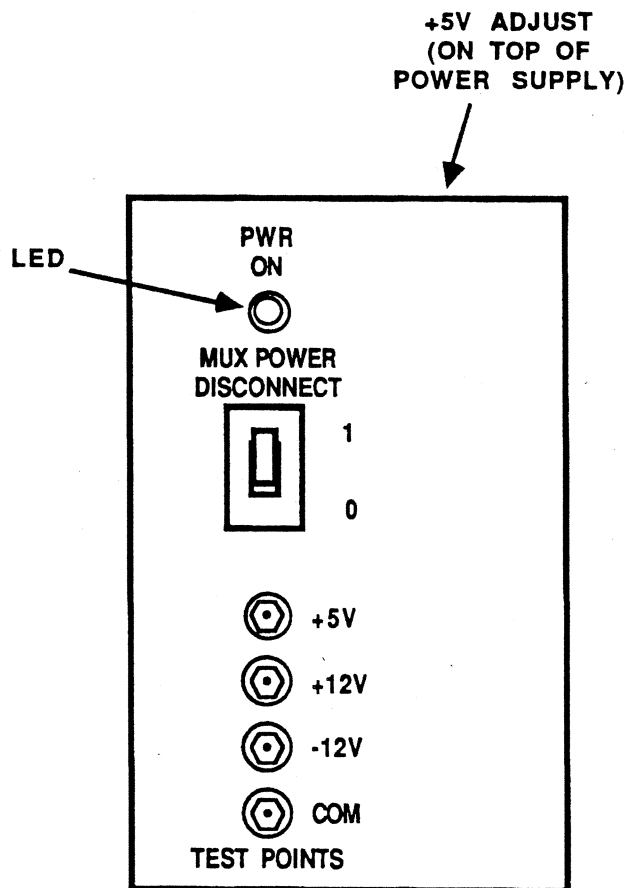
Figure 2-5. IOU Controls and Indicators

Two-Port Multiplexer Power Supply

Figure 2-6 shows and table 2-4 describes the control and indicator functions on the TPM power supply on an AT478-B but not on an AT481-B.

Table 2-4. Two-Port Multiplexer Power Supply Controls and Indicators

Panel Nomenclature	Function
PWR ON indicator	Indicates that MUX POWER DISCONNECT circuit breaker is set to ON, 1.
MUX POWER DISCONNECT circuit breaker	Controls application of 400-Hz, single-phase power to TPM power supply.
+5V, +12V, -12V, and COM test points	Allows monitoring of TPM power supply output voltages with external multimeter.



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Figure 2-6. Two-Port Multiplexer Power Supply Indicators and Controls

Two-Port Multiplexer Control Panel

Table 2-5 describes control functions on the TPM control panel of an AT478-B but not on an AT481-B.

Table 2-5. Two-Port Multiplexer Control Panel Controls

Panel Nomenclature	Function															
BAUD RATE SELECTION/PORT 0 switch	Establishes baud rate (110, 300, 600, 1200, 2400, 4800, 9600, 19.2K, or 38.4K) to be used on IOU RS-232-C port 0.															
BAUD RATE SELECTION/PORT 1 switch	Establishes baud rate (110, 300, 600, 1200, 2400, 4800, 9600, 19.2K, or 38.4K) to be used on IOU RS-232-C port 1.															
PORT OPTIONS/PORT 0 switch:																
MSG ONLY	Message only - Allows only PPs (but not the IOU's deadstart microcomputer) to communicate with this port.															
DS ENABLED	Deadstart enable - Allows activation of the IOU's deadstart microcomputer, and the subsequent use of the associated deadstart displays and commands on this port. Also enables PPs for operation on this port on completion of deadstart activity.															
DS & PWR ENABLED	No associated function; unused.															
DISABLED	Disables operation of this port of TPM.															
PORT OPTIONS/PORT 1 switch	Same options for port 1 as described for port 0.															
DIAGNOSTIC/NORMAL	NORMAL setting is used during normal use of the TPM. Setting the switch to DIAGNOSTIC enables the Operator's Terminal Diagnostic. This causes the TPM microprocessor to repeatedly read the keyboard of the selected terminal and echo back the last character read to the screen. Terminal selection is associated with the settings of the PORT OPTIONS switches as follows.															
	<table><tr><th>Port 0</th><th>Port 1</th><th>Diagnostic runs on:</th></tr><tr><td>DISABLED</td><td>DISABLED</td><td>CC598-B</td></tr><tr><td>ENABLED</td><td>DISABLED</td><td>Port 0</td></tr><tr><td>DISABLED</td><td>ENABLED</td><td>Port 1</td></tr><tr><td>ENABLED</td><td>ENABLED</td><td>Port 0</td></tr></table>	Port 0	Port 1	Diagnostic runs on:	DISABLED	DISABLED	CC598-B	ENABLED	DISABLED	Port 0	DISABLED	ENABLED	Port 1	ENABLED	ENABLED	Port 0
Port 0	Port 1	Diagnostic runs on:														
DISABLED	DISABLED	CC598-B														
ENABLED	DISABLED	Port 0														
DISABLED	ENABLED	Port 1														
ENABLED	ENABLED	Port 0														

Initialization

Initialization of the IOU subsystem precedes all other system initialization. It includes both the actions taken when the IOU is powered up as well as the action taken when the PPs are deadstarted. On completion of its own initialization, the IOU uses the system storage device to provide initialization programs and data for other system elements.

Deadstart Commands and Displays

The TPM has an internal command language consisting of deadstart and maintenance commands. These commands are entered at the system console, and enable the various initialization and deadstart displays on the console's screen. These commands and displays may be used for troubleshooting hardware failures or for diagnosing problems with system software. To these ends, they allow inspection of internal PP data and control information. In addition, they provide a means of establishing hardware scope loops to be run while viewing a hardware fault condition on an oscilloscope.

NOTE

Certain elements of the TPM command language can have a disruptive affect if used while the operating system is running. Use the commands and displays as instructed by the referenced manuals.

To execute the TPM commands, the user must first acquire the TPM Maintenance Options Display for the primary IOU (refer to the 19003 System Console Hardware Operation/Maintenance Guide). The TPM commands are described in either the associated support engineering manual or the standardized maintenance approach quick reference (SMAQR) manual. Displays are described in the system console hardware operation/maintenance guide.

A microprocessor on the TPM logic module, 1JKH, is used to initialize the IOU hardware. The microprocessor displays the deadstart program on the screen of the system console. It will also allow the operator to make changes to the contents of the deadstart program and to look at PP memory, IOU maintenance registers, IOU working registers (P, A, Q, and K), and channel status.

The microprocessor also, when directed, performs the following tasks.

- Executes a short deadstart sequence
- Executes a long deadstart sequence
- Initializes and controls the TPM hardware

Power On Initialization

At power on time, the IOU is initialized to the following state.

- The R register is set to zero for all PPs.
- A 1- μ s Master Clear is issued to all NIO channels and all PPs.
- All CIO channels are initialized, forcing them to execute a Master Clear function.

- NIO PP 0 is forced to idle.
- The 20 MHz clock frequency is set to normal.
- All PP memories are cleared and set to 4K state.
- The OS Bounds registers are cleared.
- The Fault Status registers and logic module error LEDs are cleared.
- Various bits in Environmental Control registers are cleared and set.

Deadstarting Single IOU Configurations

Deadstarting the PPs in a single IOU configuration consists of:

- Activating the deadstart display
- Selecting a short deadstart program
- Executing either a long or a short deadstart sequence

Deadstarting Dual IOU Configurations

Deadstarting the PPs in a dual IOU configuration consists of:

- Activating the deadstart display
- Selecting a short deadstart program
- Executing either a long or a short deadstart sequence

The job of coordinating the actions taken in the different IOUs is assumed by the system console. In a dual IOU PP deadstart, initialization of the IOU system occurs in two phases. In the first phase, the system console puts the secondary IOU into an inactive state by causing a 1- μ s Master Clear to be issued and PP 0 to hang. Once this occurs, the system console proceeds with either the long or the short deadstart, as specified by the operator, in the primary IOU. The second phase begins as soon as the short deadstart sequence in the primary IOU is completed. During this phase, the software running in the primary IOU PPs uses the TPM in the primary IOU, the system console, and the TPM in the secondary IOU to load and execute software in the secondary IOU.

Short Deadstart Sequence

The entry of an S command (followed by carriage return) initiates a short deadstart sequence. In this sequence, a Deadstart Master Clear is issued to the PPs and channels, and the program currently displayed on the system console screen is loaded into logical PP 0. Execution begins at word 1 of this program. At the end of the sequence, the screen of the system console is blanked in preparation for use by the software being deadstarted in PP 0. The program used is the one displayed on the system console screen, and does not necessarily have to be the same as one of the stored programs. Refer to Deadstart Programs.

Long Deadstart Sequence

The entry of an L command (followed by carriage return) initiates a long deadstart sequence. The following events occur in this sequence.

1. A Deadstart Master Clear is issued to the PPs and channels, and error status bits are cleared.
2. The long deadstart program, stored in the TPM program memory, is loaded into logical PP 0 and executed.
3. The PP register display is brought up on the right-hand side of the system console screen while the long deadstart program runs; about 15 seconds.
4. Certain error status bits are monitored to determine if the hardware fails during the long deadstart; failures are indicated via message below PP register display. On successful completion of the program, a short deadstart sequence, as described previously, is automatically initiated using the program currently displayed on the screen.

Deadstart Programs

The short deadstart sequence causes the 16-word program currently displayed on the system console to be loaded into locations 1 through 20, octal, of PP 0. Execution of the program begins at location 1 as soon as loading is complete. Commands are provided to enter or modify this program. Multiple programs may be created for different uses and may be saved in a special memory. Up to four such programs may be stored using the command entry:

SP x (where x is the program number 0 through 3)

Once the program is stored, it can be retrieved and displayed on the system console at some later time using the command entry:

GP x (where x is the program number 0 through 3)

In addition to the four programs just discussed, there are four more fixed or permanent programs which are numbered 4 through 7. These four programs can be retrieved and displayed on the system console using the command entry:

GP x (where x is the program number 4 through 7)

When a program is retrieved with the GP command, a copy of the program is displayed. If any editing of the program is done, only the copy on the screen is changed. The original version in memory is not modified; stored programs are changed only by an SP x command. Remember though, that it is possible to retrieve a program from one location, modify it, and store it at another location.

Deadstart programs can be inspected, one after the other, by pressing the space bar. Program 0 is displayed after program 7.

Permanent Deadstart Programs 4 Through 7

Four special purpose programs are permanently stored in the TPM microcomputer memory for use by maintenance personnel.

The programs are accessed with the GP x (where x is the program number 4 through 7) command. The use and description of the programs is as follows.

- Program 4 Chain test, lower channels. This program tests the internal channel registers by passing a simple program from one PP to the next. The transfer takes place on the channel with the same number as the logical PP that is to receive the program; results in channels 1 through 11 being tested.
- Program 5 Chain test, upper channels. Same as program 4, except that PPs 20 through 31 are used to test channels 20 through 31.
- Program 6 Clear errors and clear ADU. This test issues the Master Clear and Clear Error functions to the IOU, memory, and associated mainframe.
- Program 7 Display AB on CC545. This test exercises PP access to the CC545 Display Station on channel 10 of the IOU by displaying the characters AB on the screen. In the absence of PP or channel hangs, the program loops on itself. If, however, the test does not loop, it can be run in repeat mode using the scope loop feature with short deadstart.

IOU Reconfiguration

In order to deadstart either the NOS or the NOS/VE operating system, it is necessary that logical PPs 0, 1, 2, and 10 be functional. If they are all functional, the system may be deadstarted and any failing PPs, other than those mentioned, can be logically turned off using commands described under the Operator Intervention Display in the Disk Deadstart section of the CIP Reference Manual. If, however, one of these PPs is not functional, the IOU hardware configuration procedure should be used as described in the following paragraph to select a set of logical PPs from the available physical PPs such that logical PPs 1, 2, and 10 are functional.

Hardware reconfiguration of PPs is accomplished by a combination of reconfiguring either barrels and PP memories in an AT478-B, or PP memories in an AT481-B. Barrels in an AT478-B are reconfigured by using the deadstart display and command entry:

- RB x (where x is the number, 0 through 3, of the AT478-B barrel which is to be used as logical barrel 0 and which will contain logical PP 0. That is, physical NIO barrel x will become logical barrel 0.)

PP memories in each barrel can be reconfigured using the deadstart display and command entry:

- RP x (where x is the number, 0 through 4, of the physical PP memory that is to be used as logical PP memory 0.)

NOTE

The x-entry in the RP command not only designates which PP in logical barrel 0 is to be PP 0, but also which PP in logical barrel 1 is to be PP 5, which PP in logical barrel 2 is to be PP 20, and which PP in logical barrel 3 is to be PP25.

The reconfiguration specified by the RB command takes effect as soon as the command is entered. The reconfiguration resulting from the RP command does not occur until after the next Master Clear.

TPM Battery or RAM Failures

The TPM logic module (1JKH) in the AT478-B cabinet at location 23 in 1A2A2 contains a RAM to store deadstart programs 0 through 3 and the reconfiguration status. The logic module also contains a lithium battery with a life of at least 4000 hours to maintain the RAM content and to run the Calendar Clock during 400-Hz power outage.

If either the 400-Hz line voltage is removed long enough to deplete the battery charge or the TPM logic module is removed from its logic cage location, the loss of data is sensed and the following actions occur when the logic module receives power.

NOTE

The system console should remain powered up if the TPM is to be removed from its logic cage position, otherwise the remote access password and parameters, the console password, the telephone list, and the communication parameters will be lost. If this information is lost, it will either have to be reentered when the console is initialized or the console will assume the default settings are to be used.

- Deadstart programs 0 through 3 are erased and replaced with a 000300 content in word 1 and all zeros in each remaining word.
- Reconfiguration and other parameters are set to default values.
- The time-of-day is erased, and a status bit is set to indicate to software that a loss of time data has occurred. The year is set to 88.
- If Ctrl-F2 is entered, the Maintenance Options display is brought up instead of the Deadstart Options display, and the following messages are displayed for a battery fault:

BATTERY FAILURE
RE-ENTER DS PROGRAMS

Or the following message is displayed for a TPM RAM fault:

RE-ENTER DS PROGRAMS

These messages, as applicable, are removed when the first entry is typed into the deadstart program on the screen.

AT478-B/AT481-B Maintenance Aids

3

Special Tools, Test Equipment, and Materials 3-1

This chapter contains tables that complement the maintenance procedures in chapter 5 of this manual.

Special Tools, Test Equipment, and Materials

Tables 3-1, 3-2, and 3-3 list special tools, test equipment, and materials, respectively, that are used when performing maintenance on an AT478-B/AT481-B type IOU.

Table 3-1. Special Tools

Part Number	Description	How/When Used
00182131	Probe light bulb	Replacement bulb for probe light
00182425	Backpanel repair parts kit	Replacing connector pins and insulators in backpanel
00205366	Backpanel repair tool kit (pin removal tool, pin extraction tool, pin insertion tool, seating blade, insulator puller, Allen drive tool)	Removing and replacing connector pins and insulators in backpanels
00219797	Module insertion tool	Installing logic modules
00219007	Probe light	Troubleshooting backpanels
00219314	Wire spreader rod	Spreading wires on backpanel
00219417	Light stick (battery)	Backpanel troubleshooting
12205640	Torque wrench, 113 N·m (1000 lbf·in)	Torquing diodes in heat sink and installing SCRs
12210794	Spring hook	Probing backpanel wire mats
12210926	Torque wrench, 16.5 N·m (150 lbf·in)	Torquing diode lead connections and mounting circuit breakers, transformers, and relays in power distribution box
12215145	High-intensity light	Probing backpanel wire mats
12259111	Wire-wrap gun and bits	Replacing a wire-wrap connection on a backpanel pin

(Continued)

Table 3-1. Special Tools *(Continued)*

Part Number	Description	How/When Used
12259183	Wire-unwrap tool (30 gauge)	Removing a wire-wrap connection on a backpanel pin
12262555	Wire stripper (30 gauge)	Removing insulation from a wire before connecting it to a backpanel pin
12263227	Modified 1-1/8-in deep socket	Installing power supply diodes
12263442	Modified 1-1/4-in deep socket	Installing power supply diodes
12263495	Antistatic work pad	Protecting parts from electrostatic discharge during repair
12263496	Antistatic wrist strap, large	Grounding maintenance personnel while working on equipment
12263499	Antistatic bag, 35 mm by 45 mm (14 in by 18 in)	Protecting small parts from electrostatic discharge during handling and transporting
12263623	Antistatic wrist strap, small	Grounding maintenance personnel while working on equipment
53705665	Backpanel repair tool kit	Removing and replacing backpanel pins
53812060	Backpanel repair parts kit	Replacing connector pins and insulators in backpanels
75447668	Antistatic lab coat (size 38)	Whenever maintenance personnel are working in electrostatic sensitive areas
75447669	Antistatic lab coat (size 42)	
75447670	Antistatic lab coat (sizes 44 through 46)	

Table 3-2. Test Equipment

Part Number	Description	How/When Used
00219329	Fluke meter probe	Modified probe used with digital multimeter
00219490	Active scope probe	Connecting oscilloscope to circuit under test
12263230	Polarized collapsible viewing hood	Viewing faint signals on oscilloscope
12263279	Digital multimeter (Fluke 8020A)	General
12263423	Scope probe (X10) (Tektronix P6056)	Connecting oscilloscope to circuit under test
12263632	Oscilloscope (Tektronix 2465 with option 11)	Troubleshooting
12263633	Termination (50 ohm)	Connecting 50-ohm probes to channels 3 and 4 of scope
18697523	Scope probe hook tip	Connecting oscilloscope to test points
53592086	Manifold strain relief	Providing strain relief for test equipment leads

Table 3-3. Materials

Part Number	Description	How/When Used
12263294	Solvent spray brush (for spray can)	Cleaning logic modules
12263512	Freon TMS solvent (16-oz spray can)	Cleaning logic modules
12263513	Trichloroethane solvent	Cleaning logic modules
22704200	Electrical joint compound (EJC No. 2)	Installing transformers and diodes
94211400	Lint-free disposable cloths	Cleaning logic modules
94657900	Thermal grease (GE641)	Installing thermostats and SCRs

AT478-B/AT481-B Preventive Maintenance **4**

Air Filter Check	4-1
Noise/Vibration Check	4-1
Cabinet Voltage Level Verification	4-1

AT478-B/AT481-B Preventive Maintenance 4

The following preventive maintenance tasks should be performed during a convenient period of corrective maintenance.

Air Filter Check

Each IOU cabinet has an air filter located immediately below the logic cage. Slide the filter from its rack from the front of the cabinet. Use a vacuum cleaner to clean the filter. If excessive deposits require, wash the filter in a solution of warm water and household detergent, rinse it with plain water, and dry thoroughly.

Noise/Vibration Check

Each IOU cabinet has a blower assembly located at the top of the cabinet. If blower operation is accompanied by excessive noise and/or vibration, inspect the blower and blower chamber for either the presence of a foreign object or a faulty blower assembly (refer to Cabinet Blower Assembly Removal/Replacement procedure in chapter 5).

Cabinet Voltage Level Verification

Use this procedure to check that cabinet bus voltages have not changed.

- ___ 1. With power applied to the IOU cabinet to be checked, set power distribution box METER SELECT switch to OFF.
- ___ 2. Observe that meter needle rests on left indicator line. If necessary, adjust needle to line with screw on front of meter.
- ___ 3. Set METER SELECT to V1, and ensure that meter indicates 0 percent.
- ___ 4. Set METER SELECT to V2, and ensure that meter indicates 0 percent.

NOTE

When METER SELECT is set to V3 on AT478-B, it selects the Two-Port Multiplexer (TPM) power supply +5 V dc output; not +5 V dc cabinet bus.

- ___ 5. Set METER SELECT to V3, and ensure that meter indicates 0 percent.
- ___ 6. If any requirement is not met, perform IOU Cabinet Bus Voltage Adjustment procedure in chapter 5.

AT478-B/AT481-B Corrective Maintenance 5

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AT478-B/AT481-B Corrective Maintenance 5

This chapter contains step-by-step procedures for activities that might result in physical injury, equipment damage, or lost time without the use of specific instructions. Most of the procedures describe how to replace field-replaceable units (FRUs), but there are also procedures for handling electrostatic sensitive parts, cleaning logic modules, and testing selected electrical devices.

Before performing a procedure, read through it to determine the need for special tools, test equipment, materials, and skills.

WARNING

The procedures in this manual were verified on the equipment under strictly controlled conditions. Any deviation from the procedures may result in personal injury or damage to the equipment.

Since most of the procedures specify removing and applying power to the system or to individual system cabinets, you should be familiar with power-on and power-off procedures before performing maintenance.

WARNING

To prevent exposure to hazardous voltages, any power removed during a removal procedure must remain removed during the replacement procedure. The procedures assume that replacement directly follows removal and, therefore, do not repeat the power removal steps in the replacement procedures.

Simple activities like opening and closing cabinet doors are normally part of every removal and replacement action. Since all trained maintenance people know how to perform them, these activities are not included in the procedures to avoid unnecessary repetition.

Procedures

The following paragraphs describe the procedures used to maintain an IOU.

Antistatic Wrist Strap Test

Use this procedure to test the performance of an antistatic wrist strap and its grounding cord.

Tools/parts required

- A locally prepared electrode to be held by the person wearing the wrist strap. A 75 mm (3 in) length of #304 stainless steel, roundstock, that is 25 mm (1 in) in diameter and has either a banana plug receptacle or a screw connector attached to one end.
- An ohmmeter capable of measuring high resistance (0 to 100 megohms) with enough voltage to overcome skin resistance. Suggested meters include the Simpson Model 269 (20 V at 0.2 μ A) and the Triplet Model 630PL (30 V at 0.3 μ A).
- Antistatic wrist strap with grounding cord. Either large size (CDC P/N 12263496) or small size (CDC P/N 12263623) as required.

Procedure

- ___ 1. Zero the ohmmeter.
- ___ 2. Put antistatic wrist strap around wrist.
- ___ 3. Attach ground lead of ohmmeter to banana plug end of wrist strap grounding cord.
- ___ 4. Attach positive lead of ohmmeter to electrode.
- ___ 5. Holding electrode in hand, rotate wrist to simulate normal working motion while observing resistance measurement on meter. Hold metal tab on wrist strap away from wrist to ensure metal fibers in strap are being tested without benefit of tab. Resistance must be between 0.6 megohm and 5 megohm. The 0.6-megohm level provides adequate current limiting protection for wearer.
- ___ 6. If resistance value is not within the specified level, check wrist strap and grounding cord separately to locate cause.
- ___ 7. If wrist strap fails, wash it in soapy water and repeat steps 1 through 5. If wrist strap fails again, wash it or replace it.

Static-Sensitive Parts Handling

Use this procedure to avoid static discharge that destroys static-sensitive parts. Static-sensitive parts include most semiconductor devices and assemblies.

Tools/parts required

- Antistatic wrist strap with grounding cord. Either large size (CDC P/N 12263496) or small size (CDC P/N 12263623) as required.
- Antistatic bag, CDC P/N 12263499
- Antistatic work pad, CDC P/N 12263495
- Antistatic lab coat. Either size 38 (CDC P/N 75447668), size 42 (CDC P/N 5447669), or sizes 44 through 46 (CDC P/N 75447670)
- Antistatic floor mat

Part removal/replacement

- ___ 1. Obtain antistatic bag in which to place part to be removed.
- ___ 2. Stand on antistatic floor mat.
- ___ 3. Put on antistatic wrist strap and connect wrist strap grounding cord to equipment ground.
- ___ 4. Touch metal frame of equipment before touching part.
- ___ 5. Remove part and place it in antistatic bag before stepping off mat or removing wrist strap.

Parts handling at repair station

- ___ 1. Place part, contained in antistatic bag, on work surface fitted with antistatic pad connected to raised-floor grid ground.
- ___ 2. Put on antistatic wrist strap and connect wrist strap grounding cord to repair station ground.
- ___ 3. Sit at repair station.
- ___ 4. Remove part from antistatic bag.
- ___ 5. After repairing part, replace it in antistatic bag before removing wrist strap.

Logic Module Cleaning

Use this cleaning procedure to remove foreign substances from the edgeboard pins or flux from the solder connections of a logic module.

Tools/parts required

- Lint-free disposable cloths, CDC P/N 94211400
- Trichloroethane solvent (16-oz) spray can, CDC P/N 12263513
- Solvent spray brush, CDC P/N 12263294
- Disposable absorbent tissues
- Freon¹ TMS solvent (16-oz) spray can, CDC P/N 12263512

▲ CAUTION

Avoid destroying static sensitive parts by handling logic modules according to Static-Sensitive Parts Handling.

Edgeboard pins

1. Clean edgeboard pins using lint-free disposable cloth moistened with trichloroethane solvent.
2. To avoid snagging cloth fibers on pins or other sharp points near connector edge of module, use wiping motion that is parallel to pins and goes off end of pins.

Solder connections

NOTE

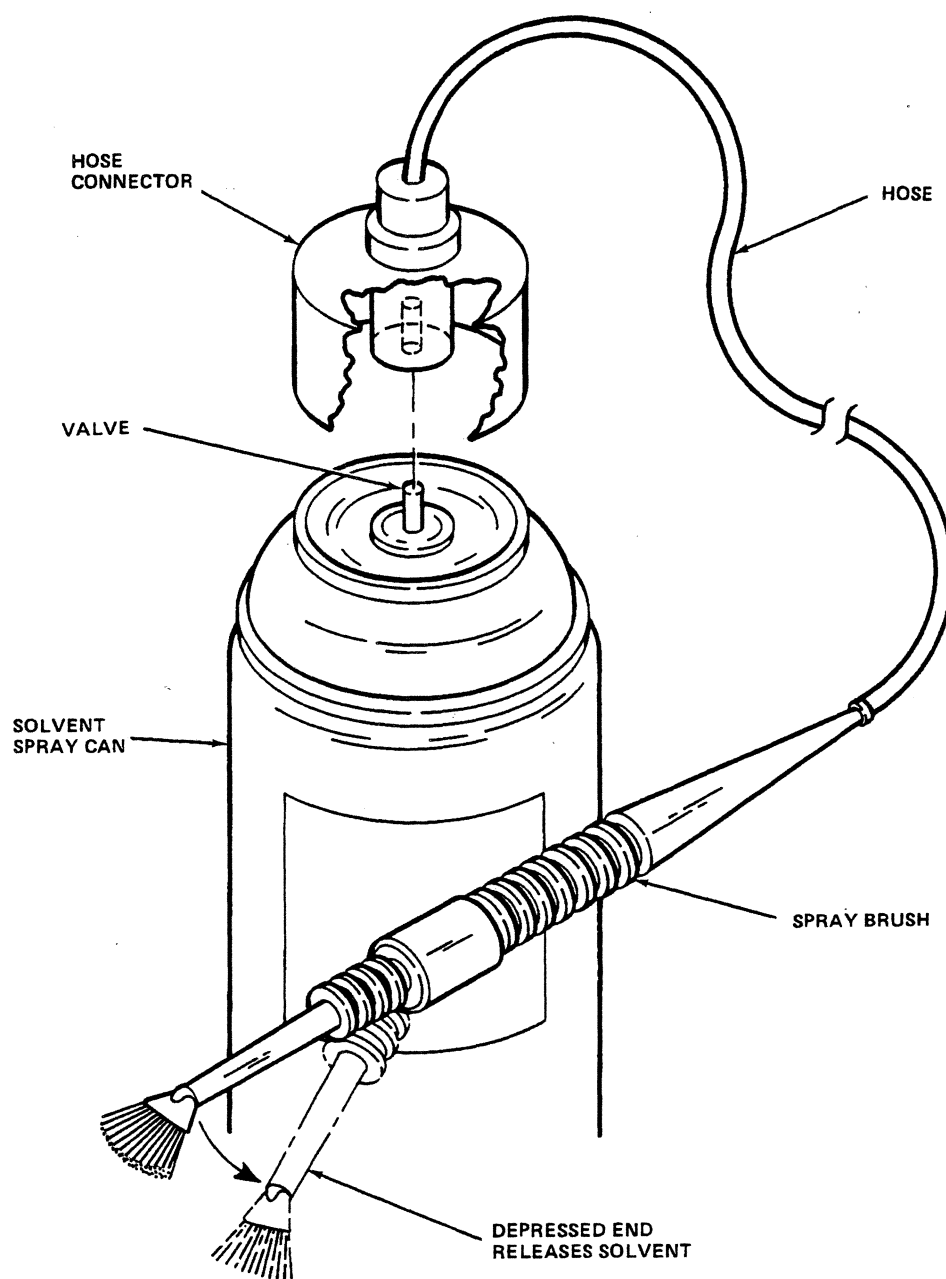
Clean logic module immediately after completion of fluxing or soldering.

1. Remove cover and spray tip from spray can of trichloroethane.
2. Press hose connector of spray brush onto valve of solvent spray can. Pressurize solvent flows to spray brush (figure 5-1).

NOTE

Pressing on lower end of brush releases solvent from brush.

1. Freon is a trade name for refrigerants made by E. I. Dupont de Nemours and Company.



00135-1

Figure 5-1. Module Cleaning Materials

- ___ 3. Place several layers of disposable absorbent tissues on work surface.
- ___ 4. Place edge of logic module on tissues and hold it at an angle to allow sprayed solvent to run onto tissues.
- ___ 5. Remove all traces of flux and particles by spraying and brushing fluxed area of module.
- ___ 6. Dry module in air for approximately 2 minutes.
- ___ 7. Thoroughly flush module and components by spraying area being cleaned with Freon TMS solvent.
- ___ 8. Dry module in air for about approximately 2 minutes.
- ___ 9. Dispose of tissues.
- ___ 10. Release pressure in hose and spray brush before storage by removing hose connector from solvent spray can.

IOU Power Removal/Application

Before removing or replacing components mounted in the IOU, power must be removed from the cabinet containing the components. Controls for removing and applying 400-Hz and 50/60-Hz power are located on the power distribution box, which is accessed from the front of the cabinet.

Remove power

- ___ 1. Set 400 Hz MAIN DISCONNECT circuit breaker on front of power distribution box to OFF (down).
- ___ 2. Set 50/60 Hz DISCONNECT circuit breaker on front of power distribution box to OFF (down).
- ___ 3. When performing removal/replacement procedure on power distribution box, set 400-Hz and 50/60-Hz circuit breakers to OFF at source (wall).

WARNING

If repairs are to be made to power distribution box, remove 400- and 50/60-Hz power from cabinet by turning circuit breakers off at source (wall).

Apply power

- ___ 1. When performing removal/replacement procedure on power distribution box, set 400-Hz and 50/60-Hz circuit breakers to ON at source (wall).
- ___ 2. Set 50/60 Hz DISCONNECT circuit breaker on front of power distribution box to ON (up).
- ___ 3. Set 400 Hz MAIN DISCONNECT circuit breaker on front of power distribution box to ON (up).

Backpanel Wire-Wrap Connection Removal/Replacement

Use this procedure to remove and/or replace a wire-wrap connection on a backpanel pin.

Tools/parts required

- Wire-unwrap tool (30 gauge), CDC P/N 12259183
- Wire-wrap gun and bits, CDC P/N 12259111
- Wire stripper (30 gauge), CDC P/N 12262555

Removal

- ___ 1. Remove power from cabinet containing wire to be removed according to IOU Power Removal/Application.
- ___ 2. Place end of wire-unwrap tool on end of wire-wrap pin that requires wire removal (figure 5-2).
- ___ 3. Push wire-unwrap tool gently toward backpanel while twisting tool counterclockwise.
- ___ 4. Pull tool and wire carefully from wire-wrap pin when wire loosens or unwraps.

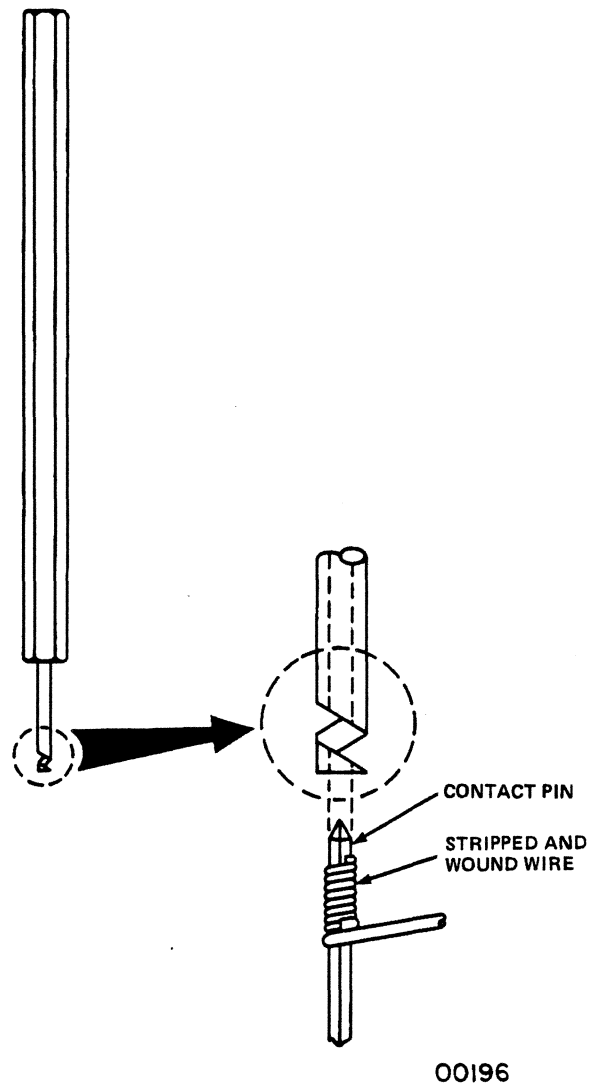
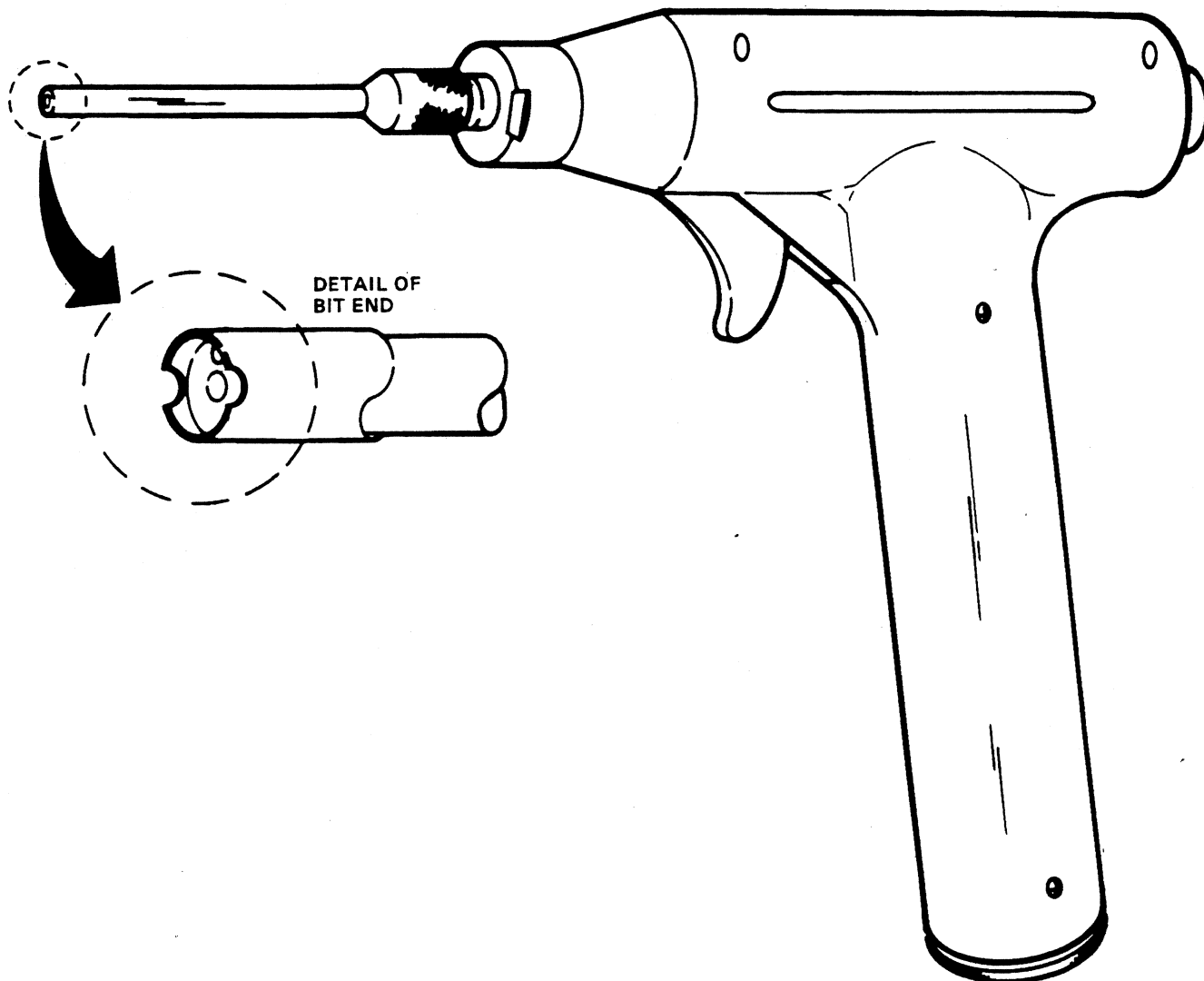


Figure 5-2. Wire-Unwrap tool

Replacement

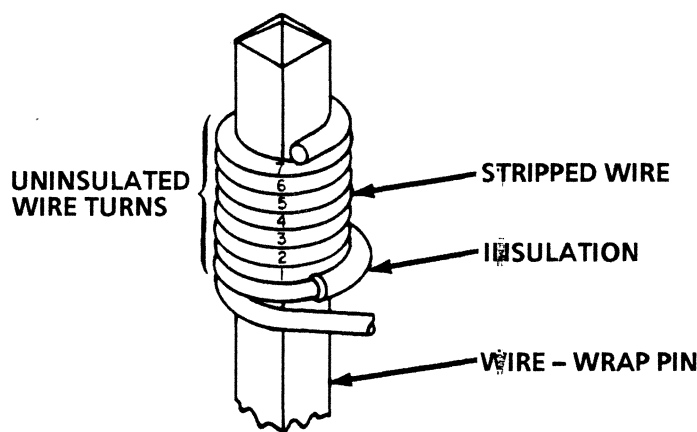
- ___ 1. Select wire-wrap bit that fits backpanel pin and size of wire being replaced. Install bit on wire-wrap gun (figure 5-3).
- ___ 2. Use wire stripper to strip about 25 mm (1 in) of insulation from end of wire to be wrapped.
- ___ 3. Insert stripped end of wire as far as it will go into small hole in wire-wrap bit.
- ___ 4. Bend wire across end of bit and back against bit shaft, holding wire against shaft.



00197

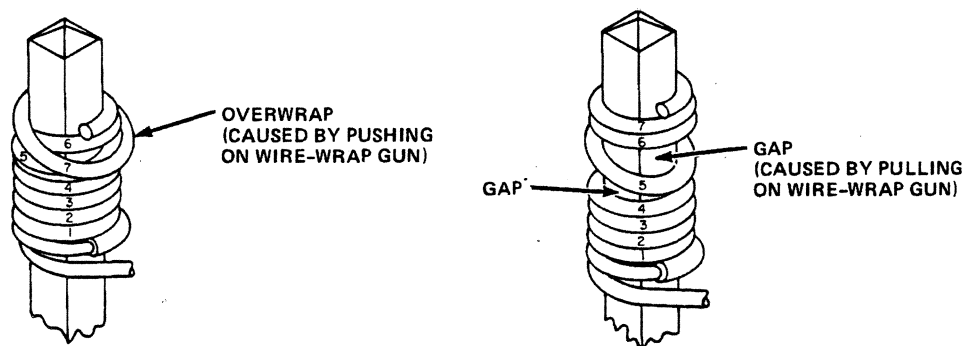
Figure 5-3. Wire-Wrap Bit Detail

- ___ 5. Place large hole in end of bit over wire-wrap pin while keeping wire-wrap gun in line with pin.
- ___ 6. Apply power to wire-wrap gun. Allow gun to back off pin during wire-wrapping process without pushing or pulling gun.
- ___ 7. Remove wire-wrap gun completely from pin. A correctly wound wire is tight on pin with seven turns of bare wire and one turn of insulated wire (figure 5-4). An incorrectly wound wire has overlap, is loosely wound, or has gaps between adjacent turns (figure 5-5).
- ___ 8. Repeat removal steps 2 through 4 and replacement steps 2 through 7 for an incorrectly wrapped wire.
- ___ 9. Apply power to cabinet according to IOU Power Removal/Application.



00198

Figure 5-4. Correct Wire-Wrap



00199

Figure 5-5. Incorrect Wire-Wrap

Logic Module Removal/Replacement

Use this procedure to remove and replace a logic module.

Tools/parts required

- Antistatic wrist strap with grounding cord. Either large size (CDC P/N 12263496) or small size (CDC P/N 12263623) as required.
- Pak insertion tool, CDC P/N 00219797
- Antistatic bag, CDC P/N 12263499

▲ CAUTION

Avoid destroying static sensitive parts by handling logic modules according to Static-Sensitive Parts Handling.

Removal

▲ CAUTION

Remove power from cabinet before removing logic module or damage may occur.

- ___ 1. Set MAIN DISCONNECT circuit breaker to OFF on front of IOU cabinet containing logic module to be removed.
- ___ 2. Put on antistatic wrist strap and connect it to chassis ground.
- ___ 3. Remove cover from logic cage.

▲ CAUTION

Applies to AT478 cabinet only: Always remove logic module from location B22 before removing logic module from location B23.

- ___ 4. Pull top and bottom extractors on front of logic module outward at same time and unseat logic module from its connector.
- ___ 5. Remove logic module by sliding it straight out of cabinet.

- ___ 6. Place logic module in antistatic bag.

Replacement

- ___ 1. Position logic module on guide rods at top and bottom of cabinet slot.
- ___ 2. Slide logic module into slot until it just contacts connector.
- ___ 3. Place module insertion tool on channels at top and bottom of logic cage (figure 5-6). Align moving block of tool with edge of logic module.
- ___ 4. Move tool handle so that tool's moving block seats logic module in connector.
- ___ 5. Replace cover on logic cage.

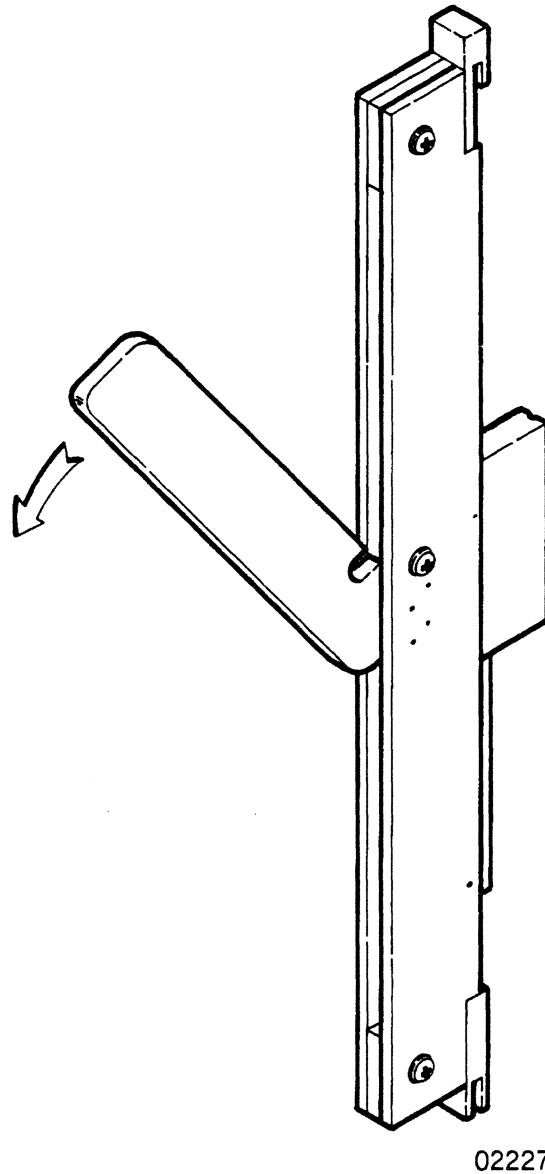


Figure 5-6. Module Insertion Tool

Logic Module Backpanel Pin Removal/Replacement

The logic module backpanel contains several rows of edgeboard connector pins (figure 5-7). Removable insulators cover the pins in each row. Use this procedure to remove and replace insulators and pins.

Tools/parts required

- Backpanel repair tool kit, CDC P/N 00182425
- Sheet of paper
- Plastic-head hammer
- Backpanel repair parts kit, CDC P/N 53812060

Removal

1. Remove power from cabinet containing backpanel to be repaired according to IOU Power Removal/Application.
2. If pin to be replaced is wire-wrapped, remove wire according to Backpanel Wire-Wrap Connection Removal/Replacement procedure.

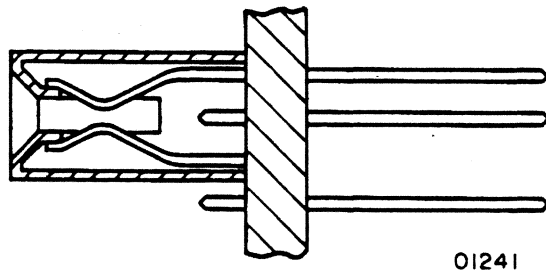
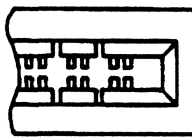
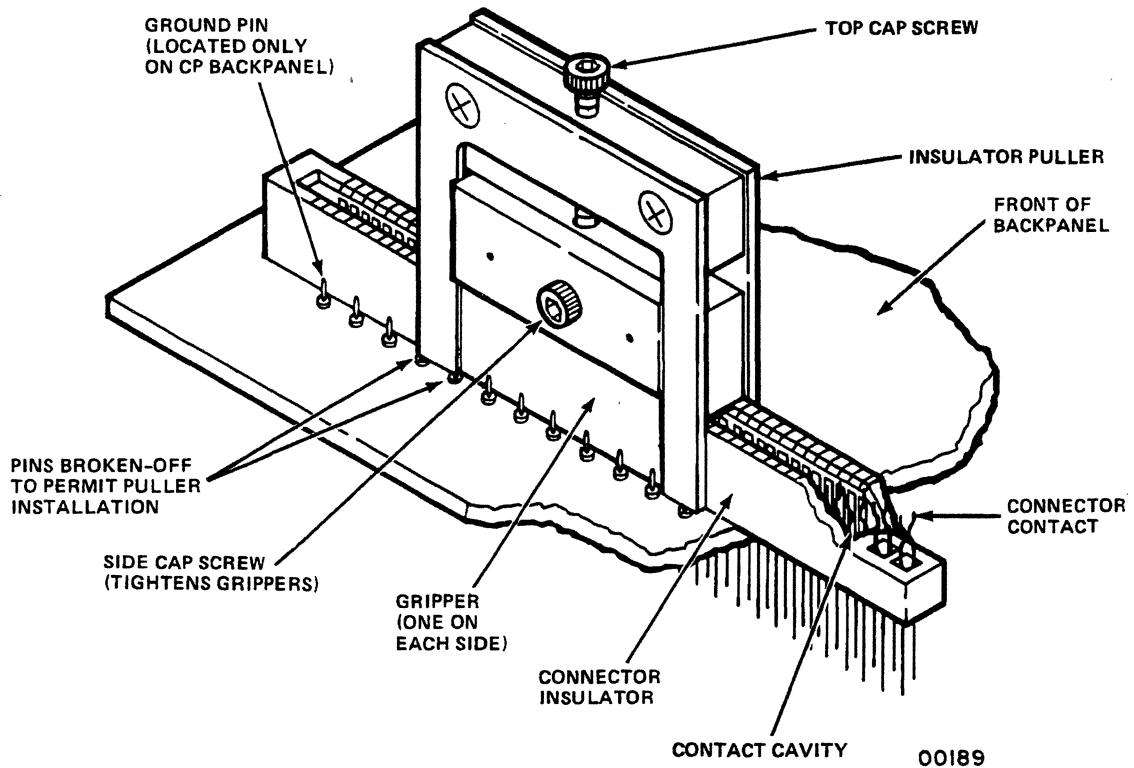


Figure 5-7. Backpanel Pins

- ___ 3. Lower grippers of insulator puller by turning top cap screw with Allen drive tool (both part of backpanel repair tool kit) (figure 5-8).
- ___ 4. Place insulator puller over connector insulator. Tighten grippers on insulator by turning side cap screw with Allen drive tool.
- ___ 5. Remove insulator from backpanel by turning top cap screw.
- ___ 6. Remove insulator from puller by turning side cap screw.



NOTE:

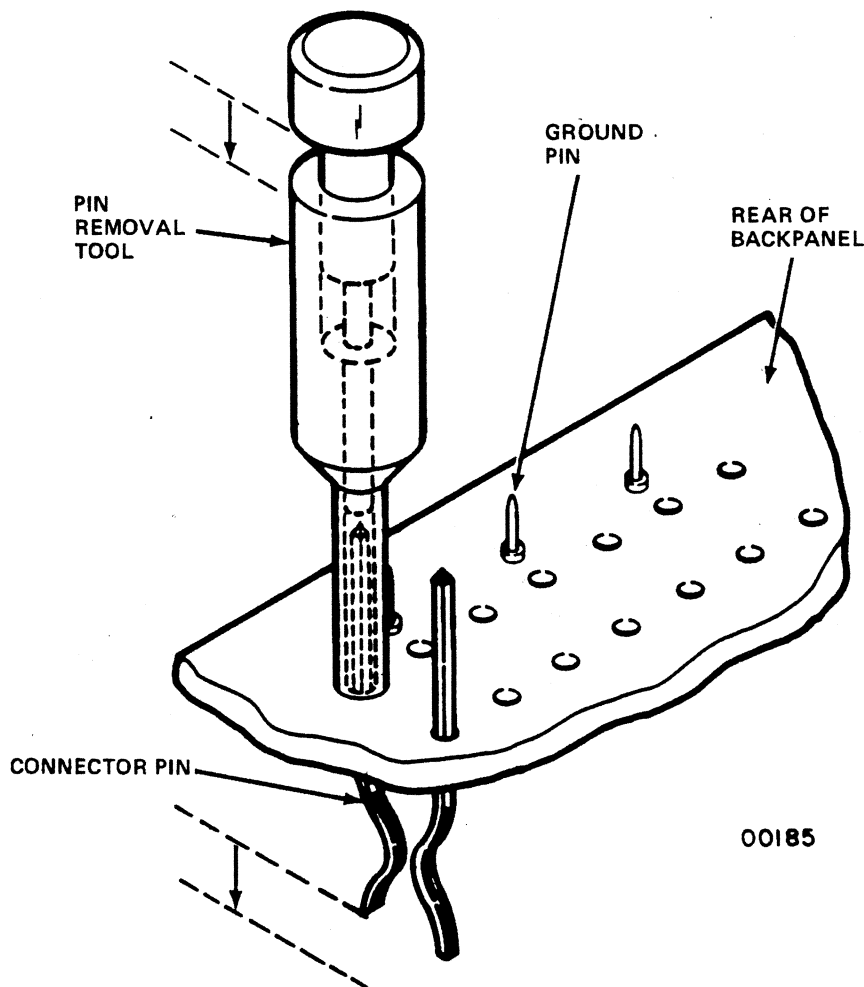
THE INSULATOR PULLER IS PART OF THE CONNECTOR REPAIR KIT.

Figure 5-8. Connector Insulator Removal

- ___ 7. Remove defective pin from backpanel using pin removal tool or pin extraction tool (both part of backpanel repair tool kit).

To use pin removal tool:

- ___ a. Place sheet of paper under front of connector to catch pin.
- ___ b. At rear of backpanel, set pin removal tool over pin to be removed (figure 5-9).
- ___ c. Push pin out of backpanel by tapping end of pin removal tool lightly with plastic-head hammer.
- ___ d. Remove pin from front of backpanel.
- ___ e. Remove sheet of paper.



NOTES:

1. THIS PIN REMOVAL TOOL IS FOR USE WITH THE ZIF BACKPANEL CONNECTOR PINS.
2. THE PIN REMOVAL TOOL FOR CM HAS A SLIGHTLY DIFFERENT SHAPE BUT IS USED IN THE SAME WAY.
3. THE PIN REMOVAL TOOL IS PART OF THE CONNECTOR REPAIR KIT.

Figure 5-9. Pin Removal Tool

To use pin extraction tool:

- ___ a. At front of backpanel, insert small hooks of pin extraction tool under tabs of pin to be removed (figure 5-10).
- ___ b. Start pin removal by pivoting tool against backpanel and away from pin.
- ___ c. Insert large hooks of pin extraction tool under tabs of pin.
- ___ d. Finish pin removal by pivoting tool against backpanel and away from pin.

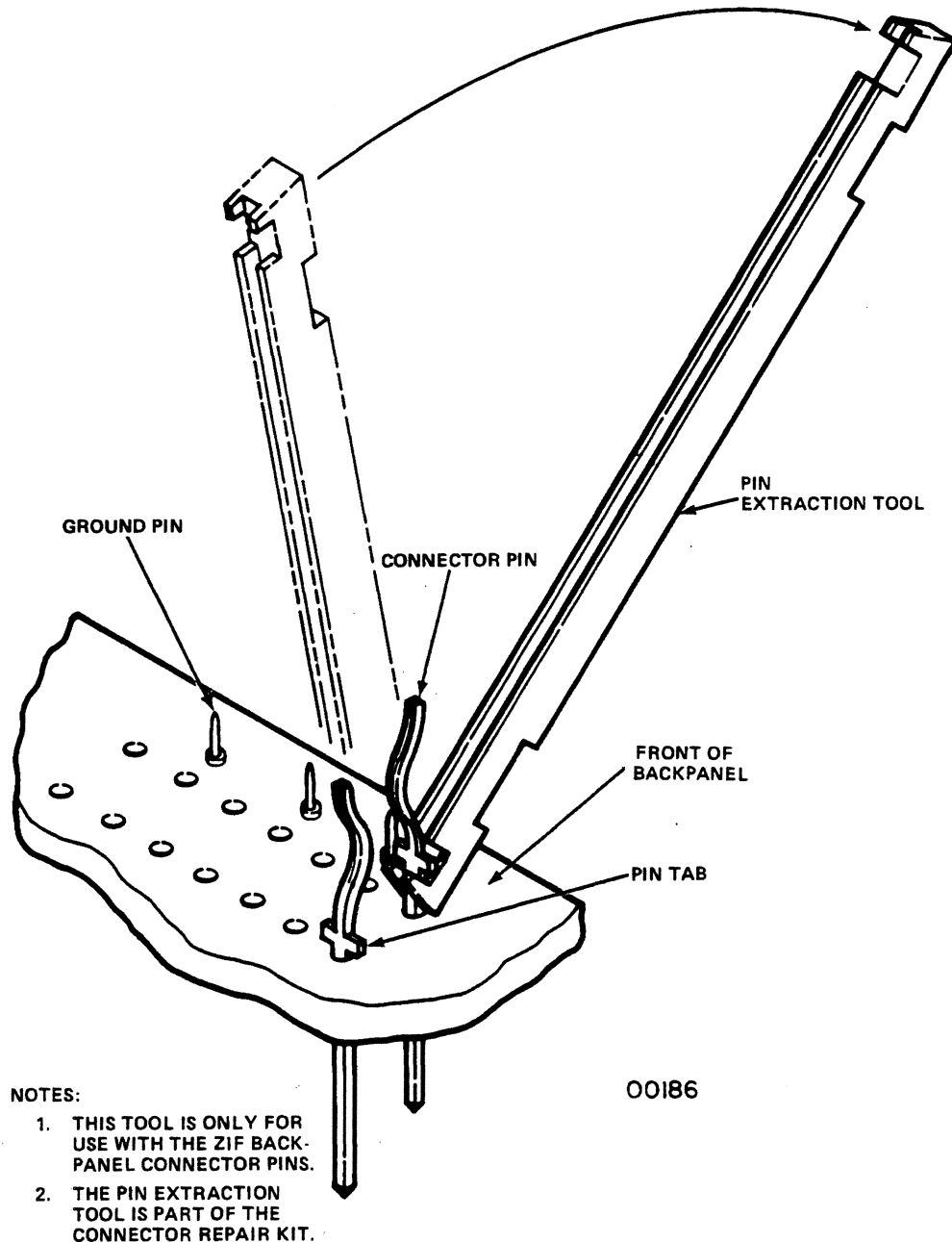


Figure 5-10. Pin Extraction Tool

Replacement

- 1. Select replacement pin from backpanel repair parts kit (figure 5-11).

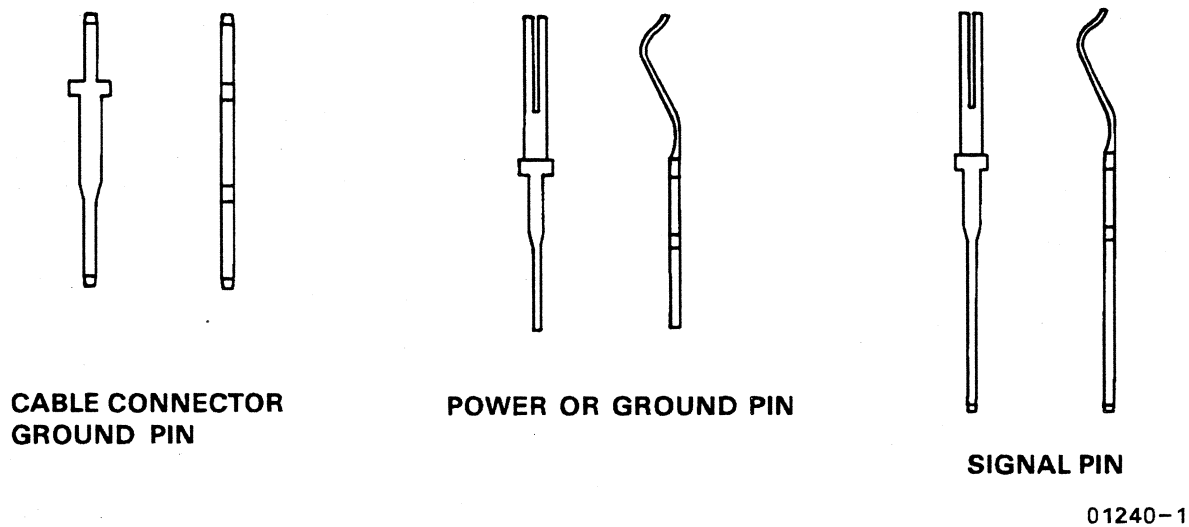


Figure 5-11. Replacement Pins

- 2. Place pin in pin insertion tool (part of backpanel repair tool kit). Hold top of pin in tool with finger (figure 5-12).
- 3. Insert pin into backpanel as far as it will go without forcing it.
- 4. Tap pin insertion tool lightly with plastic-head hammer until pin is fully seated in backpanel.

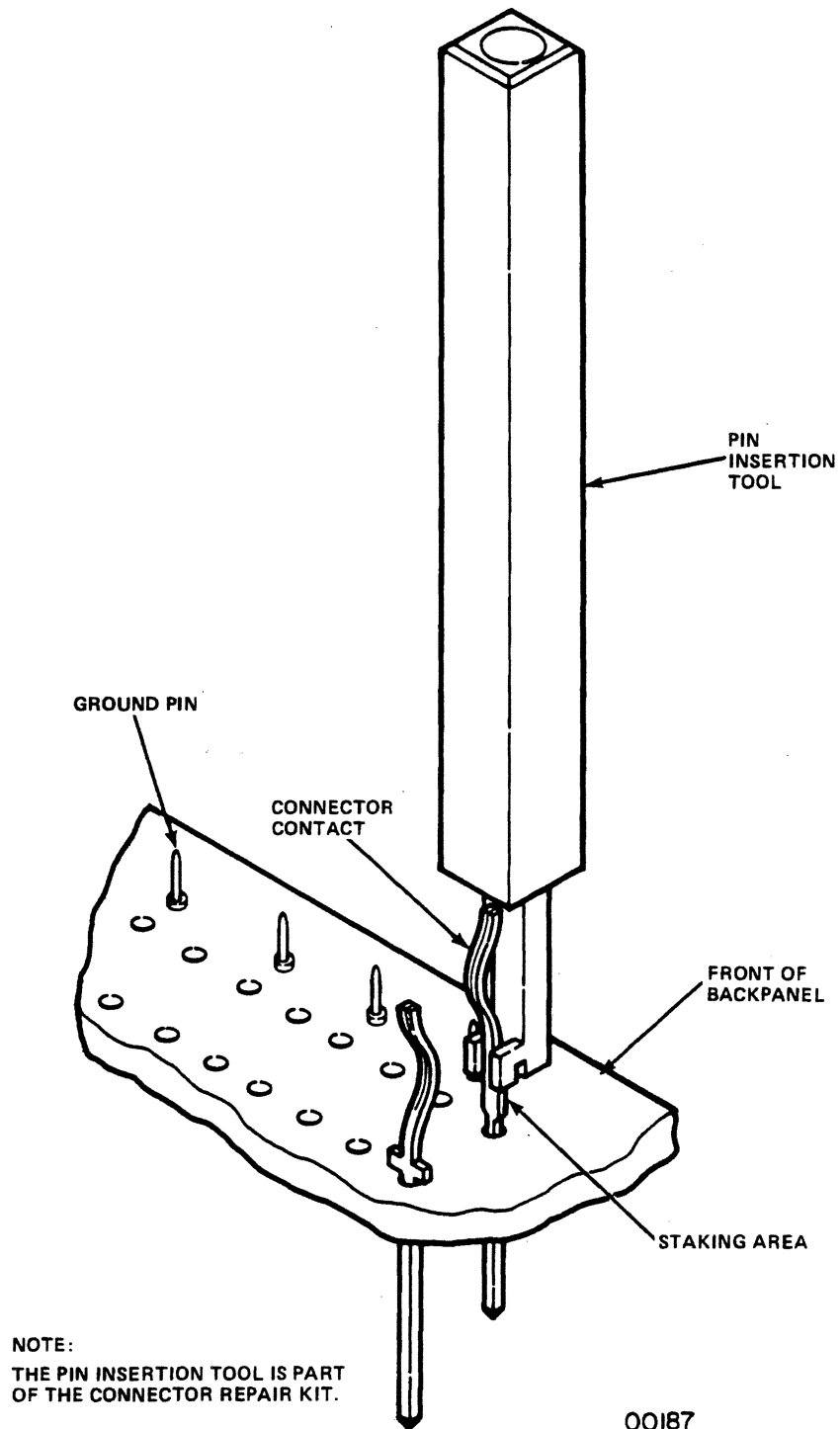


Figure 5-12. Pin Insertion Tool

- ___ 5. Remove tool and inspect pin. If pin is aligned with other pins, go to next step. Otherwise, replace pin again.

NOTE

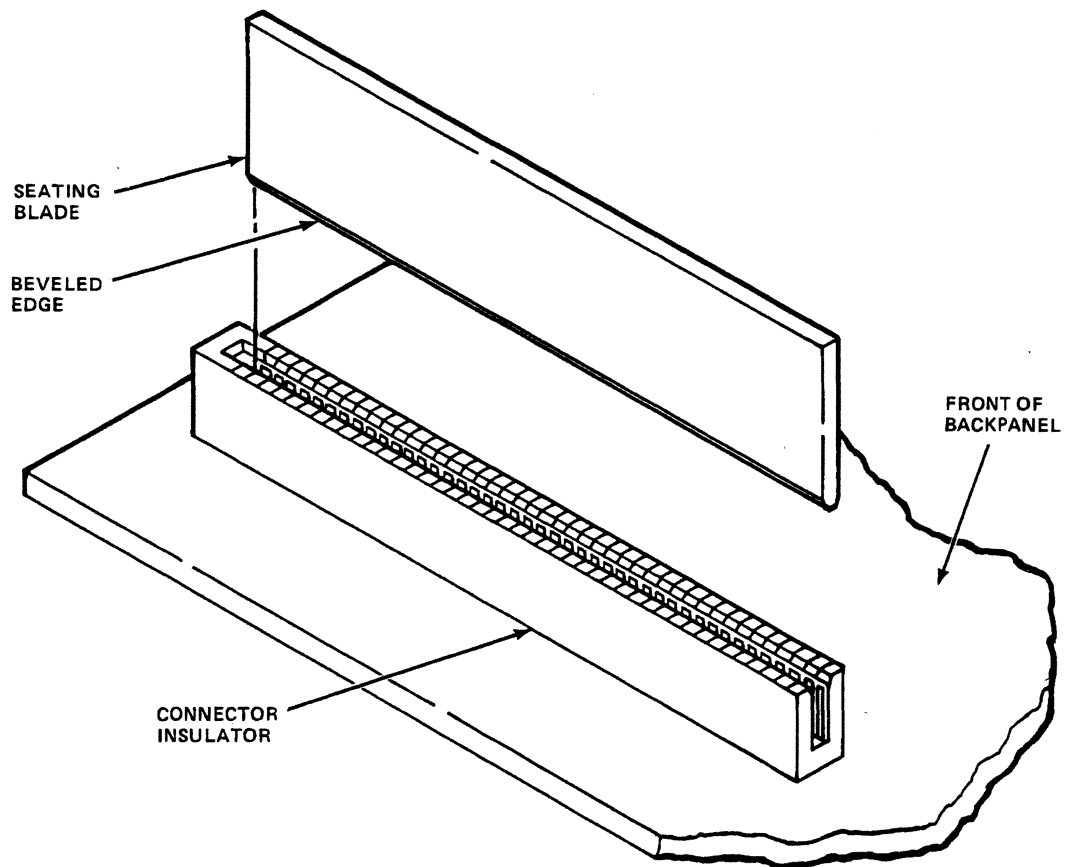
To ensure a tight fit over the pins, use a replacement insulator from the backpanel repair parts kit.

- ___ 6. Select replacement insulator from backpanel repair parts kit. Position insulator loosely over pins.
- ___ 7. Inspect pins through opening in insulator. If all pins are uniformly in place, go to next step. Otherwise, replace bent pins.

⚠ CAUTION

Do not apply any pressure on the replacement insulator. Applying pressure on the insulator severely damages the pins under the insulator that have not been aligned and spread (steps 8 and 9).

- ___ 8. Align pins in cavities of insulator by lightly inserting beveled edge of seating blade into insulator with rocking motion (figure 5-13). Seating blade is part of backpanel repair tool kit.
- ___ 9. Spread pins in cavities of insulator by pressing firmly on top of seating blade, sliding it between rows of pins to bottom of insulator.
- ___ 10. Seat insulator on pins by sharply tapping seating blade several times with plastic-head hammer.
- ___ 11. Remove seating blade from insulator.
- ___ 12. Inspect insulator and pins. Insulator must be flush with backpanel undamaged. Pins must be aligned with cavities and with each other.
- ___ 13. If pin is supposed to have wire wrapped to it, strip and install wire according to Backpanel Wire-Wrap Connection Removal/Replacement procedure.
- ___ 14. Apply power to cabinet according to IOU Power Removal/Application.



SEATING BLADE IS PART OF THE CONNECTOR REPAIR KIT.

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Figure 5-13. Connector Insulator Installation

-2.2 V Transformer Removal/Replacement

Use this procedure to remove and/or replace transformer 1T1 (-2.2 V) from an IOU cabinet.

Tool/parts required

- Phillips screwdriver
- Flat-blade screwdriver
- 3/8-in socket set
- Electrical joint compound (EJC No. 2), CDC P/N 22704200
- Torque wrench 16.5 N·m (150 lbf·in), CDC P/N 12210926

Removal

- ___ 1. Remove power from cabinet containing transformer to be replaced according to IOU Power Removal/Application.
- ___ 2. Remove screws and transformer support bracket connecting outboard ends of transformers together.
- ___ 3. Remove cover from transformer 1T1 terminal board. Label lead wire connections and disconnect lead wires at terminal board (figure 5-14).
- ___ 4. Remove screws, nuts, and washers securing white feeder bus to center tap bar of transformer 1T1.
- ___ 5. Remove SCR flexible power lead from center tap bar of transformer 1T1.
- ___ 6. Label connections and remove nuts and washers securing diode leads to transformer 1T1 secondary terminals on side of transformer.
- ___ 7. Unlock power distribution box (remove screw from bracket on front lower-left corner) and swing it out from cabinet front.
- ___ 8. Remove Torx-head screws securing transformer 1T1 to chassis vertical heat sink weldment.

⚠ WARNING

The transformer weighs 35 kg (77 lb), and requires two persons to move.

- ___ 9. Lift transformer out of cabinet rear.

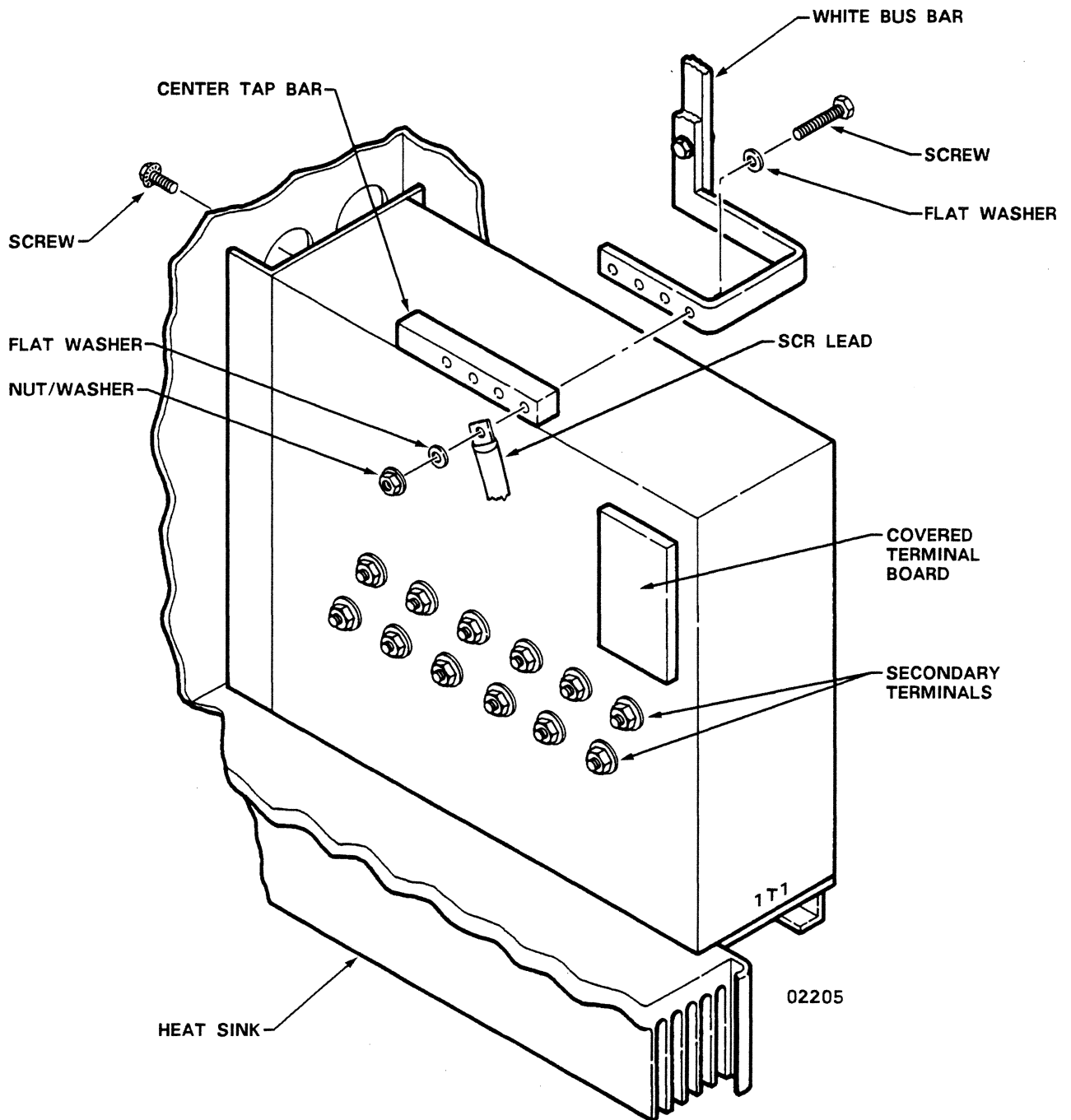


Figure 5-14. 1T1 Transformer

Replacement

Perform steps of removal procedure in reverse order.

NOTE

Ensure that rubber strips are in place beneath and behind the transformer. Lightly coat bus to center tap bar connection and diode lead to transformer side stud connections with electrical joint compound. Torque nuts that connect diode leads to transformer side lugs and nuts that secure bus to center tap bar to 14.6 N·m (130 lbf·in).

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-5.2 V Transformer Removal/Replacement

Use this procedure to remove and/or replace transformer 1T3 (-5.2 V) from an IOU cabinet.

Tool/parts required

- Phillips screwdriver
- Flat-blade screwdriver
- 3/8-in socket set
- Electrical joint compound (EJC No. 2), CDC P/N 22704200
- Torque wrench 16.5 N·m (150 lbf·in), CDC P/N 12210926

Removal

- ___ 1. Remove power from cabinet containing transformer to be replaced according to IOU Power Removal/Application.
- ___ 2. Remove screws and transformer support bracket connecting outboard ends of transformers together.
- ___ 3. Remove cover from transformer 1T3 terminal board. Label lead wire connections and disconnect lead wires at terminal board (figure 5-15).
- ___ 4. Remove screws, nuts, and washers securing blue feeder bus to center tap bar of transformer 1T3.
- ___ 5. Remove SCR flexible power lead from center tap bar of transformer 1T3.
- ___ 6. Label connections and remove nuts securing diode leads to transformer 1T3 secondary terminals on both sides of transformer.
- ___ 7. Remove screws, spacers, and washers securing transformer to horizontal heat sink weldment.

WARNING

The transformer weighs 50 kg (110 lb), and requires two persons to move.

- ___ 8. Lift transformer out of cabinet rear.

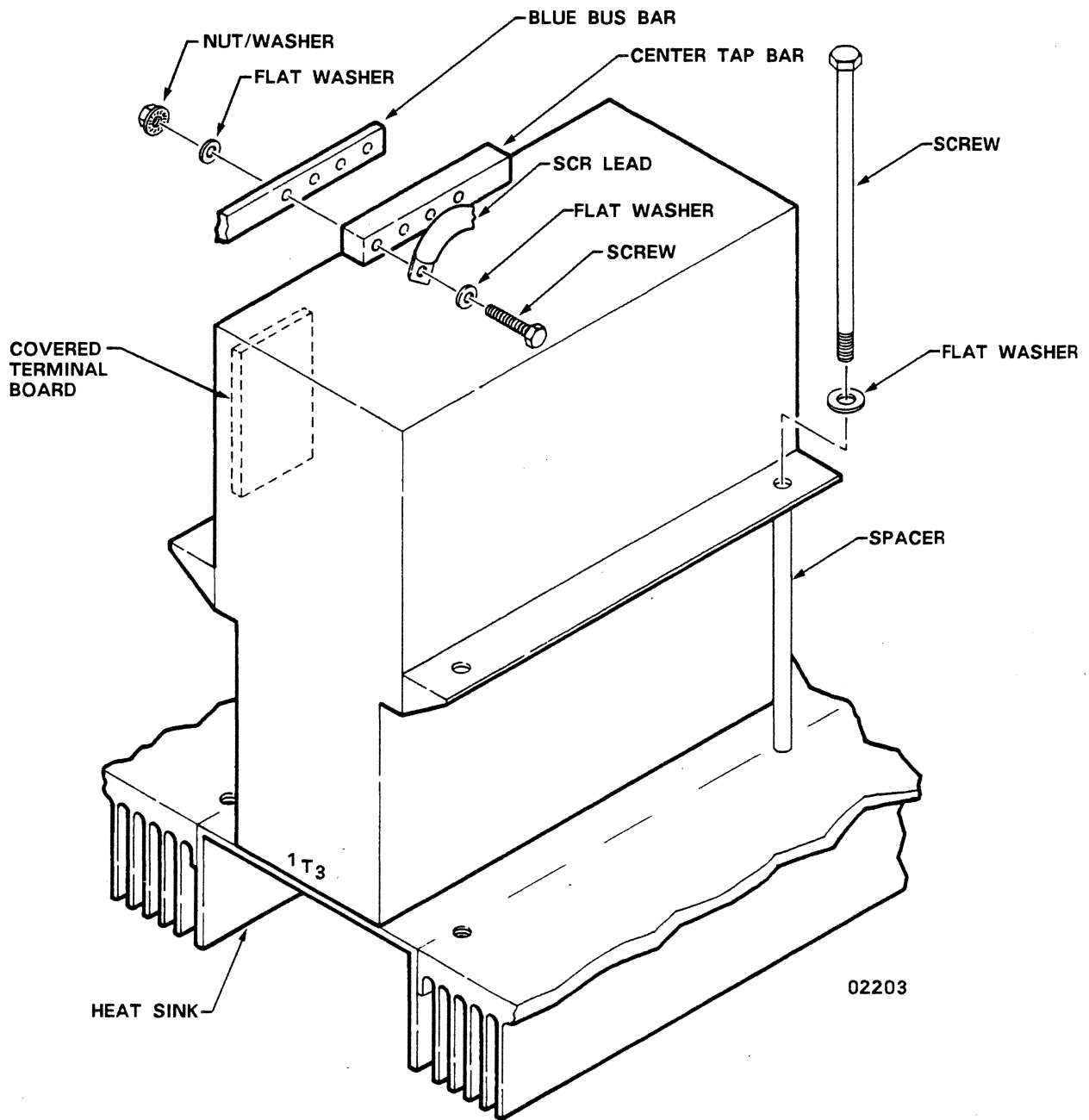


Figure 5-15. 1T3 Transformer

Replacement

Perform steps of removal procedure in reverse order.

NOTE

Ensure that rubber strips are in place beneath the transformer. Lightly coat bus to center tap bar connection and diode lead to transformer side stud connections with electrical joint compound. Torque nuts that connect diode leads to transformer side lugs and nuts that secure bus to center tap bar to 14.6 N·m (130 lbf·in).

+5.0 V Transformer Removal/Replacement

NOTE

This procedure does not apply to an AT478-B IOU cabinet.

Use this procedure to remove and/or replace transformer 1T2 (+5.0 V) from an IOU cabinet.

Tool/parts required

- Phillips screwdriver
- Flat-blade screwdriver
- 3/8-in socket set
- Electrical joint compound (EJC No. 2), CDC P/N 22704200
- Torque wrench 16.5 N·m (150 lbf·in), CDC P/N 12210926

Removal

- ___ 1. Remove power from cabinet containing transformer to be replaced according to IOU Power Removal/Application.
- ___ 2. Remove screws and transformer support bracket connecting outboard ends of transformers.
- ___ 3. Remove cover from transformer 1T2 terminal board. Label lead wire connections and disconnect lead wires at terminal board (figure 5-16).
- ___ 4. Remove screws, nuts, and washers securing red feeder bus to center tap bar of transformer 1T2.
- ___ 5. Label connections and remove nuts securing diode leads to transformer 1T2 secondary terminals on side of transformer.
- ___ 6. Unlock power distribution box (remove screw from bracket on front lower-left corner) and swing it out from cabinet front.
- ___ 7. Remove Torx-head screws securing transformer 1T2 to chassis vertical heat sink weldment.

WARNING

The transformer weighs 35 kg (77 lb), and requires two persons to move.

- ___ 8. Lift transformer out of cabinet rear.

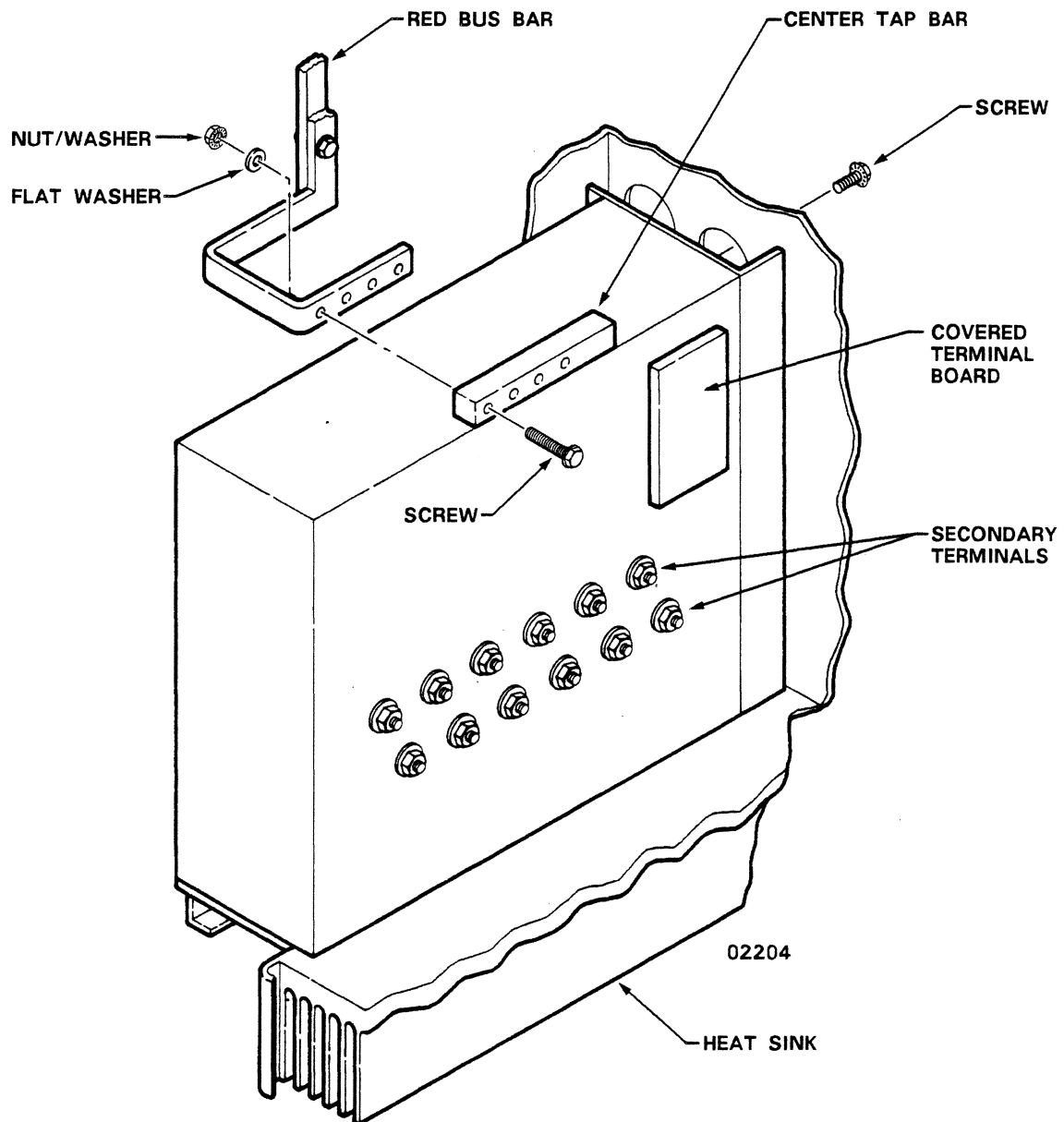


Figure 5-16. 1T2 Transformer

Replacement

Perform steps of removal procedure in reverse order.

NOTE

Ensure that rubber strips are in place beneath and behind the transformer. Lightly coat bus with electrical joint compound to center tap bar connection and diode lead to transformer side stud connections. Torque nuts that connect diode leads to transformer side lugs and nuts that secure bus to center tap bar to 14.6 N·m (130 lbf·in).

Power Supply Diode Removal/Replacement

Use this procedure to remove and/or replace a diode associated with one of the three (two for AT478-B) power supply transformers installed on the cabinet base heat sink. The diodes and their related power supplies are as follows:

CR1 through CR12	-5.2 V, 300-A diodes
CR13 through CR24	+5.0 V, 150-A diodes (not applicable to AT478-B)
CR26 through CR36	-2.2 V, 150-A diodes

Tools/parts required

- Ratchet wrench
- Modified 1-1/8-in deep socket, CDC P/N 12263227
- Modified 1-1/4-in deep socket, CDC P/N 12263442
- Scotch Brite
- Torque wrench 113 N·m (1000 lbf·in), CDC P/N 12205640
- Thermal grease (GE641), CDC P/N 94657900

Removal

- ___ 1. Remove power from cabinet containing diode to be replaced according to IOU Power Removal/Application.
- ___ 2. Disconnect and remove parts, such as power buses, that restrict removal of power diode. Determining which parts must be removed will vary depending on diode to be removed.
- ___ 3. Remove nut and washer connecting diode lead to transformer secondary terminal.
- ___ 4. Unscrew diode from heat sink with ratchet wrench and appropriate deep socket: CR1 through CR12 use 1-1/4-in socket all others use 1-1/8-in socket.

Replacement

- ___ 1. Clean top surface of heat sink around diode mounting hole with Scotch Brite.
- ___ 2. Apply thermal grease to underside of base and diode threads.
- ___ 3. Screw diode into heat sink assembly.
- ___ 4. Tighten diode using applicable substep:
 - ___ a. Torque diodes CR1 through CR12 to 30.5 N·m (270 lbf·in)
 - ___ b. Torque diodes CR13 through CR36 to 18.8 N·m (165 lbf·in)
- ___ 5. Connect diode lead to transformer side lug with nut and washer and torque nut to 14.6 N·m (130 lbf·in).
- ___ 6. Replace any parts disconnected during removal.
- ___ 7. Apply power to cabinet according to IOU Power Removal/Application.

Power Distribution Box Removal/Replacement

A power distribution box is in the bottom of each IOU cabinet, and is accessed from the front of the cabinet. The power distribution box distributes 400-Hz and 50/60-Hz power to the transformers. In addition to main 400-Hz and 50/60-Hz circuit breakers, the power distribution box also has circuit breakers for the individual dc voltages, as well as autotransformers and a meter which are used to adjust the dc voltages. The power distribution box contains the cabinet fault detection and warning circuits.

Tools/parts required

- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set

Removal

- ___ 1. Set LOC/REM switch to LOC on power distribution box of each IOU chassis present in the system.
- ___ 2. Remove power to mainframe by pressing and releasing POWER OFF switch on power unit.
- ___ 3. Remove power from cabinet containing faulty power distribution box according to IOU Power Removal/Application.
- ___ 4. Unlock power distribution box and swing it out from cabinet front.
- ___ 5. Disconnect 1P1 through 1P5 (1P1 through 1P5 and 1P7 on AT478-B) on lower right side of power distribution box.
- ___ 6. Disconnect 1A4A1P2, 1A4A1P5, and 1A4A1P11 on upper right side of power distribution box.
- ___ 7. Remove ground strap next to hinge.
- ___ 8. Lift box up and away from hinges.
- ___ 9. If this power distribution box is being replaced with a different power distribution box, transfer the written voltage values from NOMINAL VOLTAGE label on this box to NOMINAL VOLTAGE label on replacement box.

Replacement

- ___ 1. Perform steps of removal procedure in reverse order.
- ___ 2. Perform IOU Cabinet Bus Voltage Adjustment procedure.

Power Multiplexer Board Removal/Replacement

The power multiplexer board in each cabinet interfaces that cabinet to the system power unit. The power multiplexer board mounts on the under-side of the blower assembly chamber, and is accessed from the rear of the cabinet.

Tools/parts required

- 3/8-in socket set

Removal

- ___ 1. Set LOC/REM switch to LOC on power distribution box of each IOU chassis present in the system.
- ___ 2. Remove power to mainframe by pressing and releasing POWER OFF switch on power unit.
- ___ 3. Remove power from cabinet containing power multiplexer board to be replaced according to IOU Power Removal/Application.
- ___ 4. Label connections to power multiplexer board and unplug each connector.
- ___ 5. Remove four screws and spacers securing power multiplexer board to underside of blower assembly chamber.

Replacement

- ___ 1. Set switches on replacement board to the same positions as those on board being replaced.
- ___ 2. Perform steps of removal procedure in reverse order.

Power Distribution Box Circuit Breaker Removal/Replacement

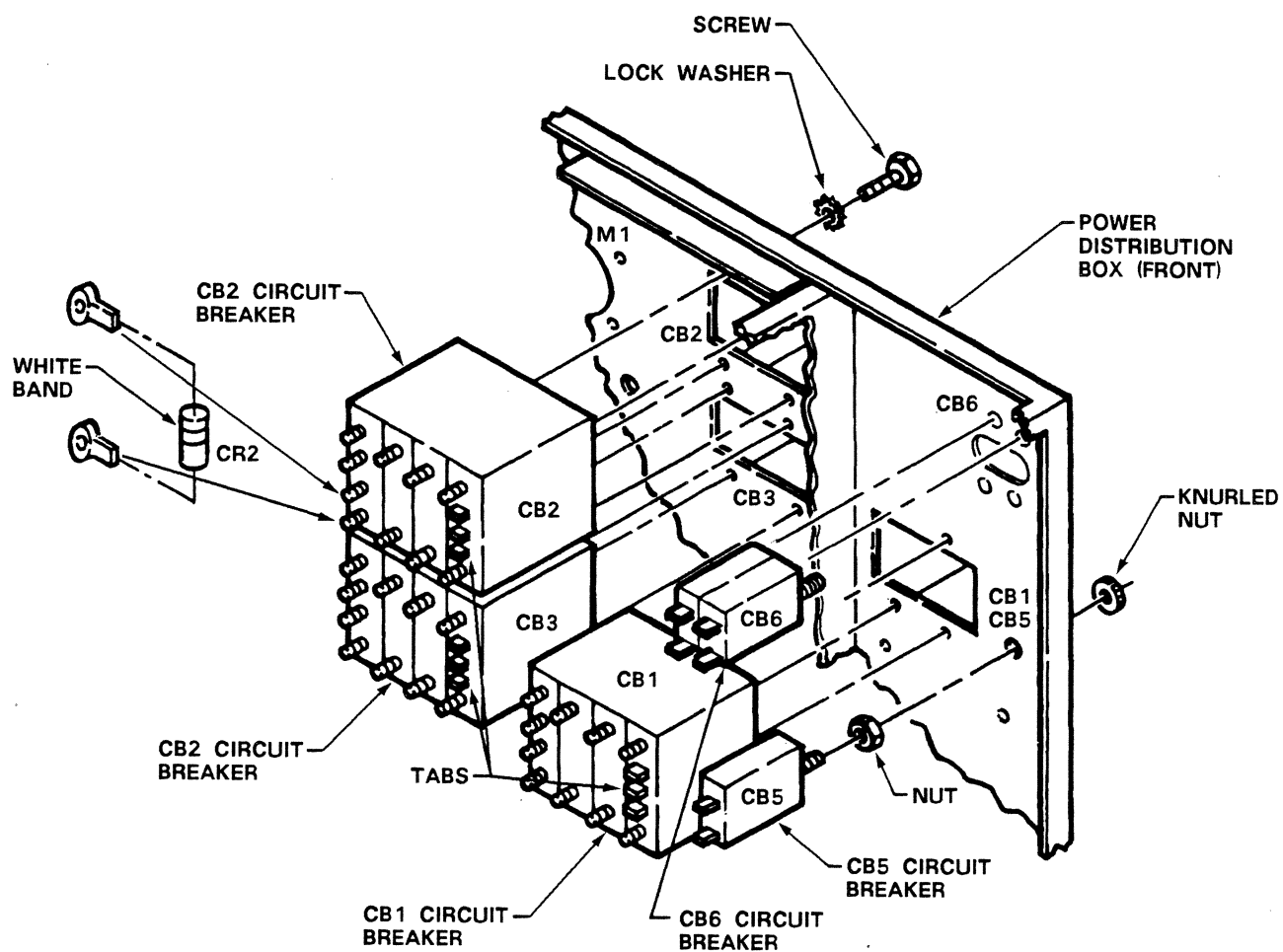
The power distribution box contains six circuit breakers (AT478-B contains five): 50/60 Hz DISCONNECT, 400 Hz MAIN DISCONNECT, V1 (-2.2 V) DISCONNECT, V2 (-5.2 V) DISCONNECT, V3 (+5.5 V) DISCONNECT (AT478-B does not contain CB3), and PUSH TO RESET for control circuit. Use this procedure to remove/replace any of the circuit breakers.

Tools/parts required

- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set
- Torque wrench 16.5 N·m (150 lbf·in), CDC P/N 12210926

Removal

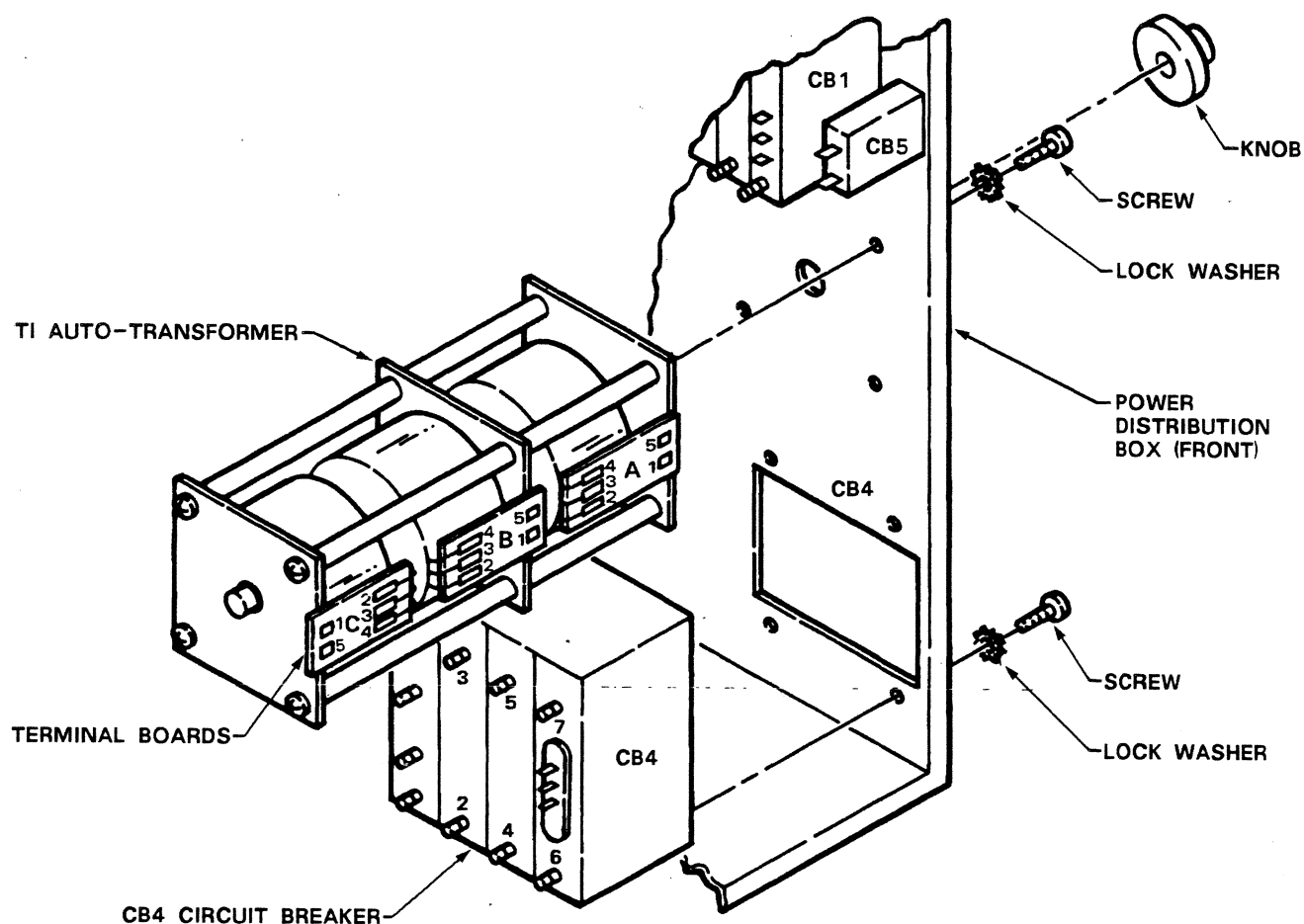
- ___ 1. Remove power from cabinet containing circuit breaker to be replaced according to IOU Power Removal/Application.
- ___ 2. Remove screws holding left-side metal screen to power distribution box. Remove screen.
- ___ 3. Label wires, then remove from terminals of faulty circuit breaker.
- ___ 4. Remove screws (knurled nut on CB5) holding faulty circuit breaker to power distribution box front panel (figures 5-17 and 5-18). Remove circuit breaker.



00616-1

Figure 5-17. CB1, CB2, CB3, CB5, and CB6 Circuit-Breaker Installation

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Figure 5-18. CB4 Circuit-Breaker Installation

Replacement

- ___ 1. Perform steps of removal procedure in reverse order with the following exceptions:
 - ___ a. CB1 - Torque nuts to 1.15 N·m (10 lbf·in).
 - ___ b. CB2 - Attach diode leads to terminals 1b and 2b with white-striped end of diode connected to 1b.
 - ___ c. CB4 - Torque nuts to 1.92 N·m (17 lbf·in).

Power Distribution Box Autotransformer Removal/Replacement

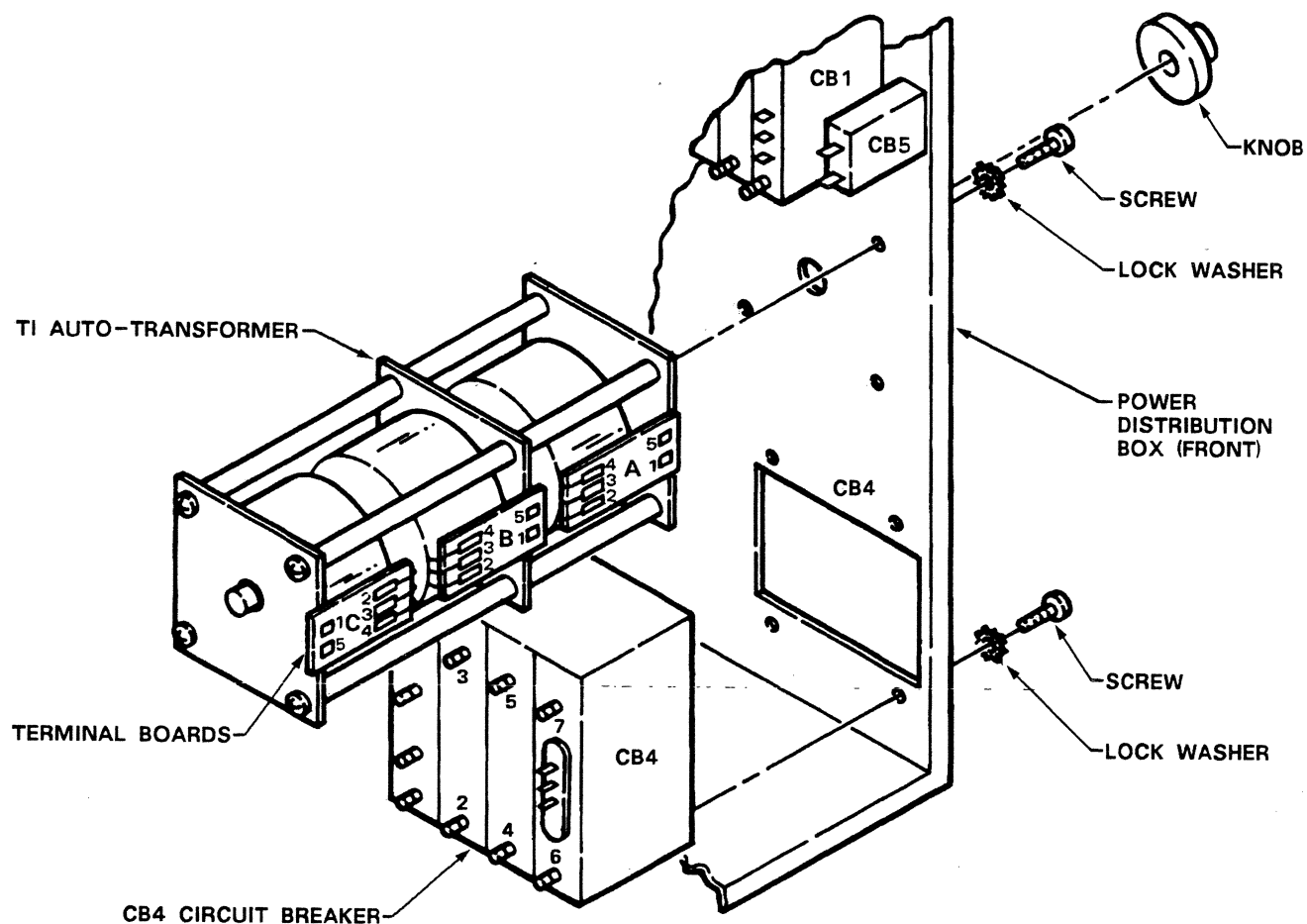
The power distribution box contains three autotransformers (AT478-B contains two). Use this procedure to remove and replace any of the autotransformers.

Tools/parts required

- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set
- Allen wrench assortment
- Torque wrench 16.5 N·m (150 lbf·in), CDC P/N 12210926

Removal

- ___ 1. Remove power from cabinet containing autotransformer to be replaced according to IOU Power Removal/Application.
- ___ 2. Remove power distribution box according to Power Distribution Box Removal/Replacement.
- ___ 3. Remove any parts that restrict removal of autotransformer:
 - ___ a. A4T1 - Remove left-side wire screen and connector side panel.
 - ___ b. A4T2/3 - (AT478-B does not contain A4T3.) Remove power warning board according to Power Distribution Box Power Warning Board Removal/Replacement.
- ___ 4. Remove power distribution box back.
- ___ 5. Identify and remove all wires on faulty autotransformer.
- ___ 6. Loosen Allen screw securing knob to autotransformer shaft. Remove knob.
- ___ 7. Hold autotransformer in place while unfastening and removing the screws and lock washers securing autotransformer. Remove autotransformer (figures 5-19 and 5-20).



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Figure 5-19. T1 Autotransformer

Replacement

- ___ 1. Perform steps of removal procedure in reverse order with following exceptions:
 - ___ a. T1 - Torque screws on wire terminals to 0.79 N·m (7.00 lbf·in).
 - ___ b. T2/T3 - Torque screws on wire terminals to 1.92 N·m (17.00 lbf·in).
- ___ 2. Perform IOU Cabinet Bus Voltage Adjustment procedure.

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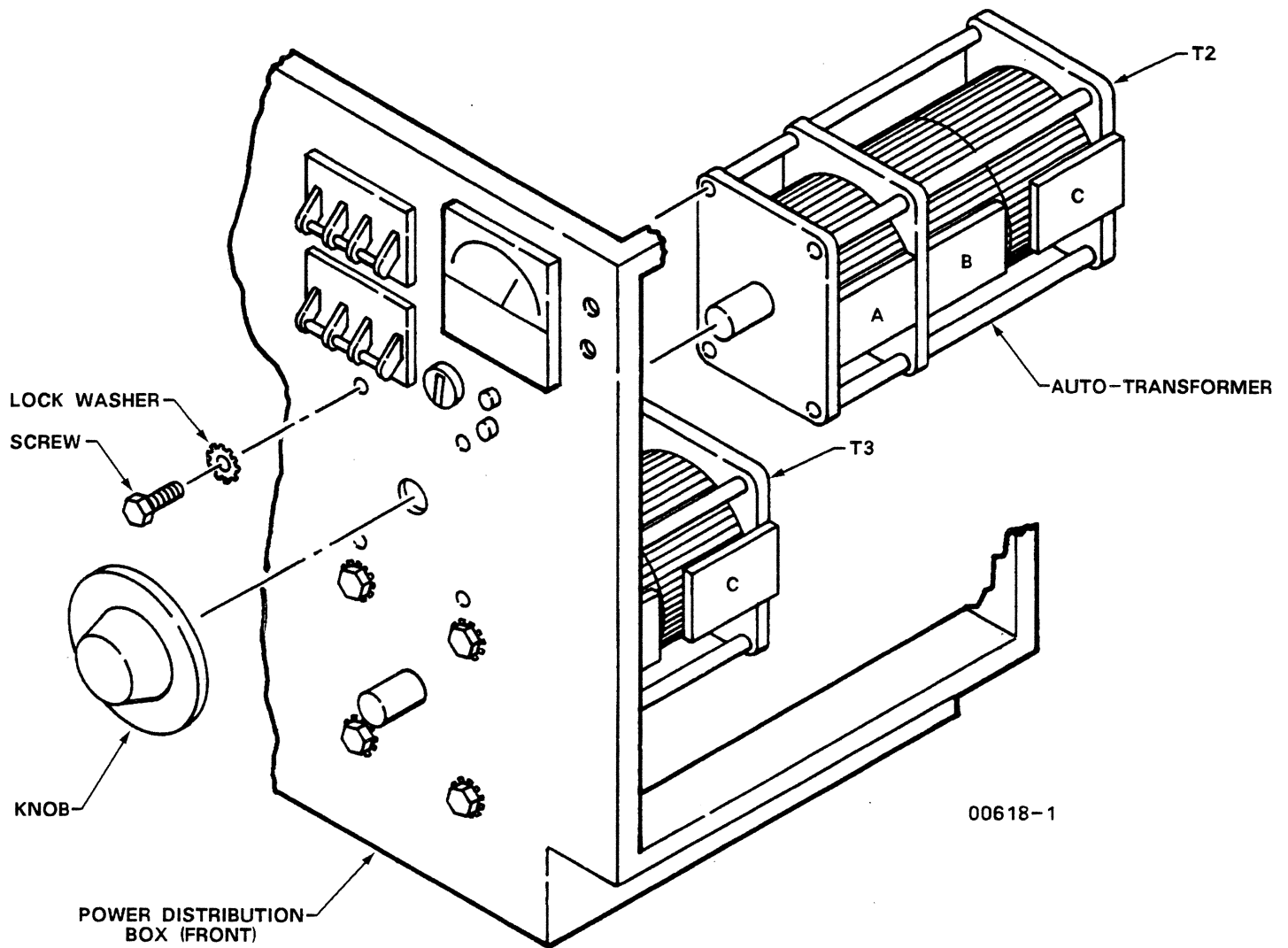


Figure 5-20. T2 and T3 Autotransformers

Power Distribution Box Transformer Removal/Replacement

Transformer A4T4 is on the floor of the power distribution box. Transformer A4T5 is suspended from a plate across the top center of the power distribution box. Separate procedures are provided for each transformer.

Tools/parts required

- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set
- Soldering iron
- Torque wrench 16.5 N·m (150 lbf·in), CDC P/N 12210926

A4T4 Transformer removal

- ___ 1. Remove power to the cabinet containing the faulty transformer according to IOU Power Removal/Application.
- ___ 2. Unfasten screws and remove left-side wire screen from power distribution box.
- ___ 3. Label wires and unsolder them from transformer terminals.
- ___ 4. Unfasten and remove screws, lock washers, and nuts holding transformer.
- ___ 5. Remove transformer.

A4T4 Transformer replacement

Perform steps of removal procedure in reverse order.

A4T5 Transformer removal

- ___ 1. Remove power to cabinet containing the faulty transformer according to IOU Power Removal/Application.
- ___ 2. Unfasten screws and remove top and back screen of power distribution box.
- ___ 3. Unscrew and remove phenolic cover from terminal board.
- ___ 4. Label wires and disconnect them from terminal board.
- ___ 5. While supporting transformer from below, remove bolts securing transformer mounting plate to angle brackets (figure 5-21).
- ___ 6. Remove transformer and mounting plate through top of power distribution box.
- ___ 7. Remove plate from transformer.

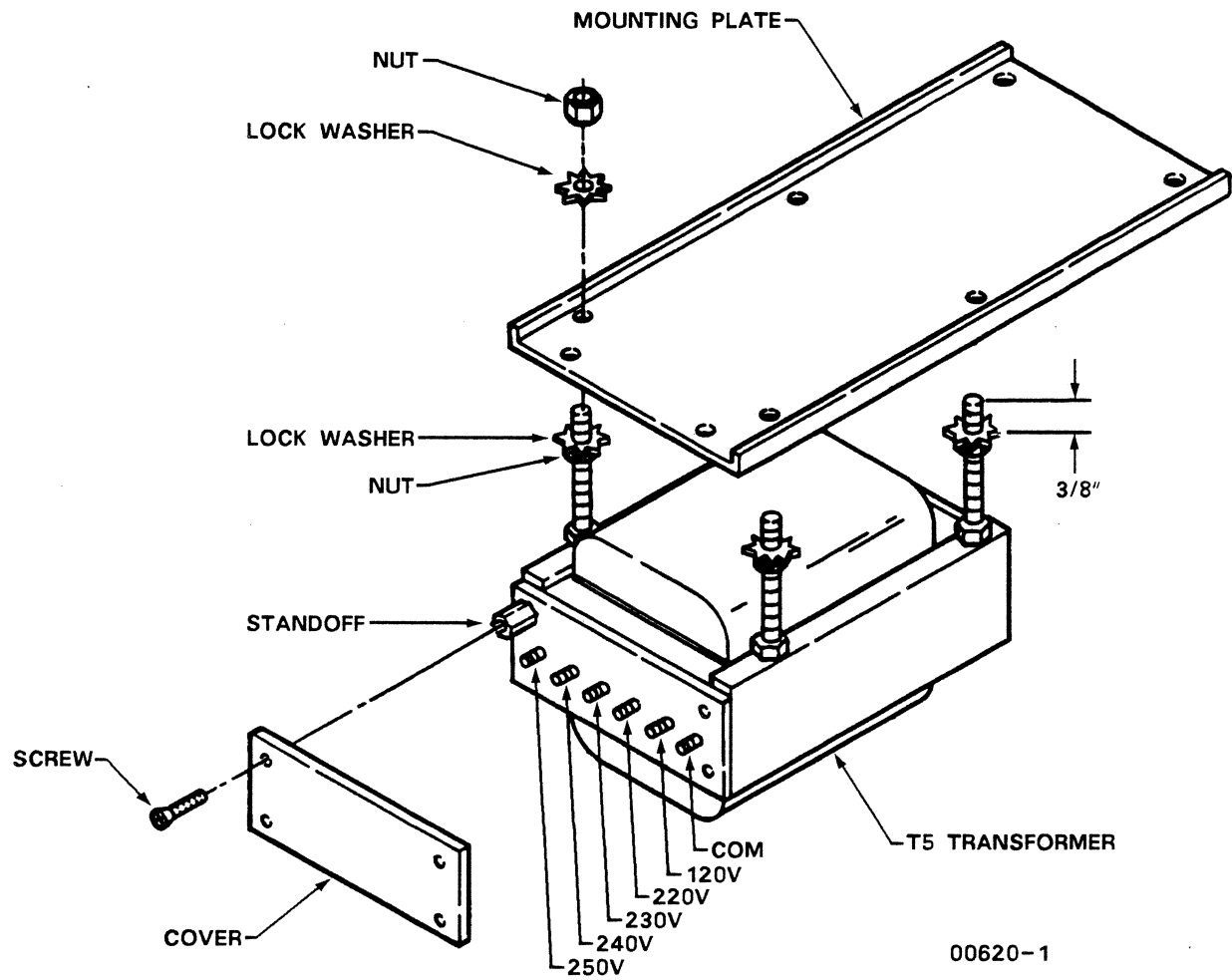
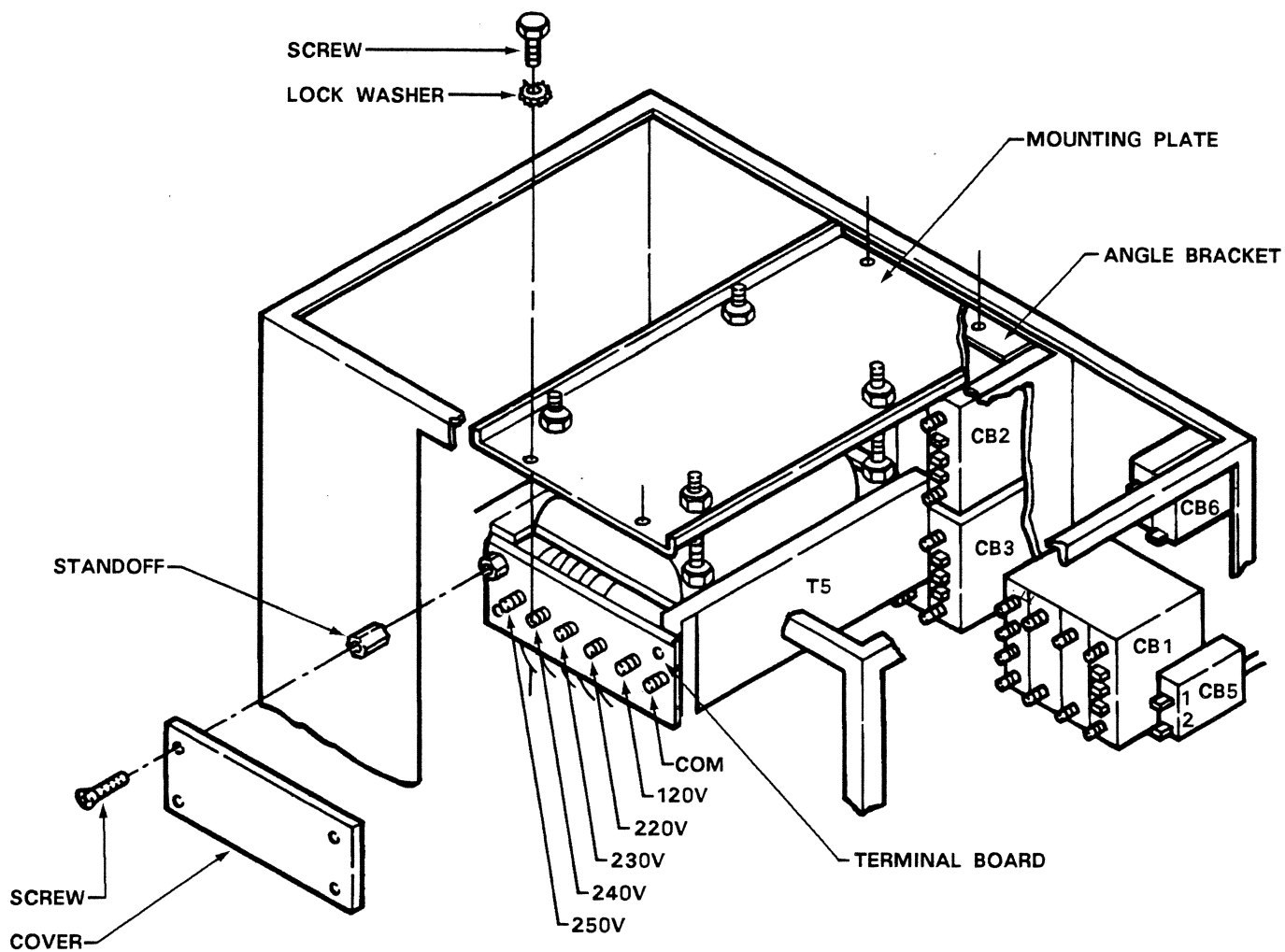


Figure 5-21. T5 Transformer

A4T5 Transformer replacement

- ___ 1. Thread a hex nut on each transformer stud until 3/8 in exists between nut and end of stud. Add one lock washer to each stud.
- ___ 2. Position mounting plate over transformer studs. Align mounting plate over angle brackets and fasten with screws.
- ___ 3. Orient transformer and mounting plate. Align mounting plate over angle brackets and fasten with screws (figure 5-22).
- ___ 4. Remove phenolic cover from terminal board, attach wires to transformer terminal board, and torque connections to 1.15 N·m (10 lbf·in).
- ___ 5. Attach transformer terminal board phenolic cover with nuts.
- ___ 6. Attach top plate and back screen to power distribution box.
- ___ 7. Replace power distribution box according to Power Distribution Box Removal/Replacement.



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Figure 5-22. Transformer Installation

Power Distribution Box Meter Removal/Replacement

The meter and its multiplier board are installed on the power distribution box front panel.

Tools/parts required

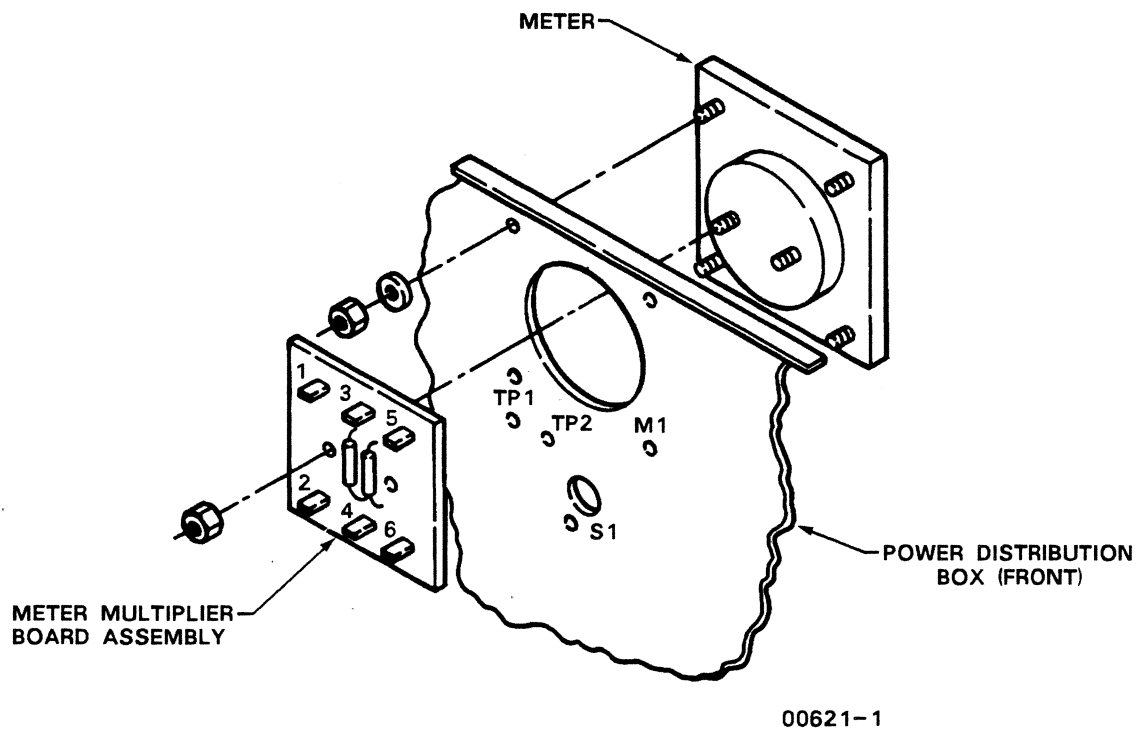
- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set

Removal

- ___ 1. Remove power to cabinet containing faulty meter according to IOU Power Removal/Application.
- ___ 2. Remove nuts securing multiplier board to meter (figure 5-23). Set board aside.
- ___ 3. Remove nuts securing meter to panel. Remove meter.

Replacement

- ___ 1. Perform steps of removal procedure in reverse order.
- ___ 2. Perform IOU Cabinet Bus Voltage Adjustment procedure.

**Figure 5-23. Meter Installation**

Power Distribution Box Relay Removal/Replacement

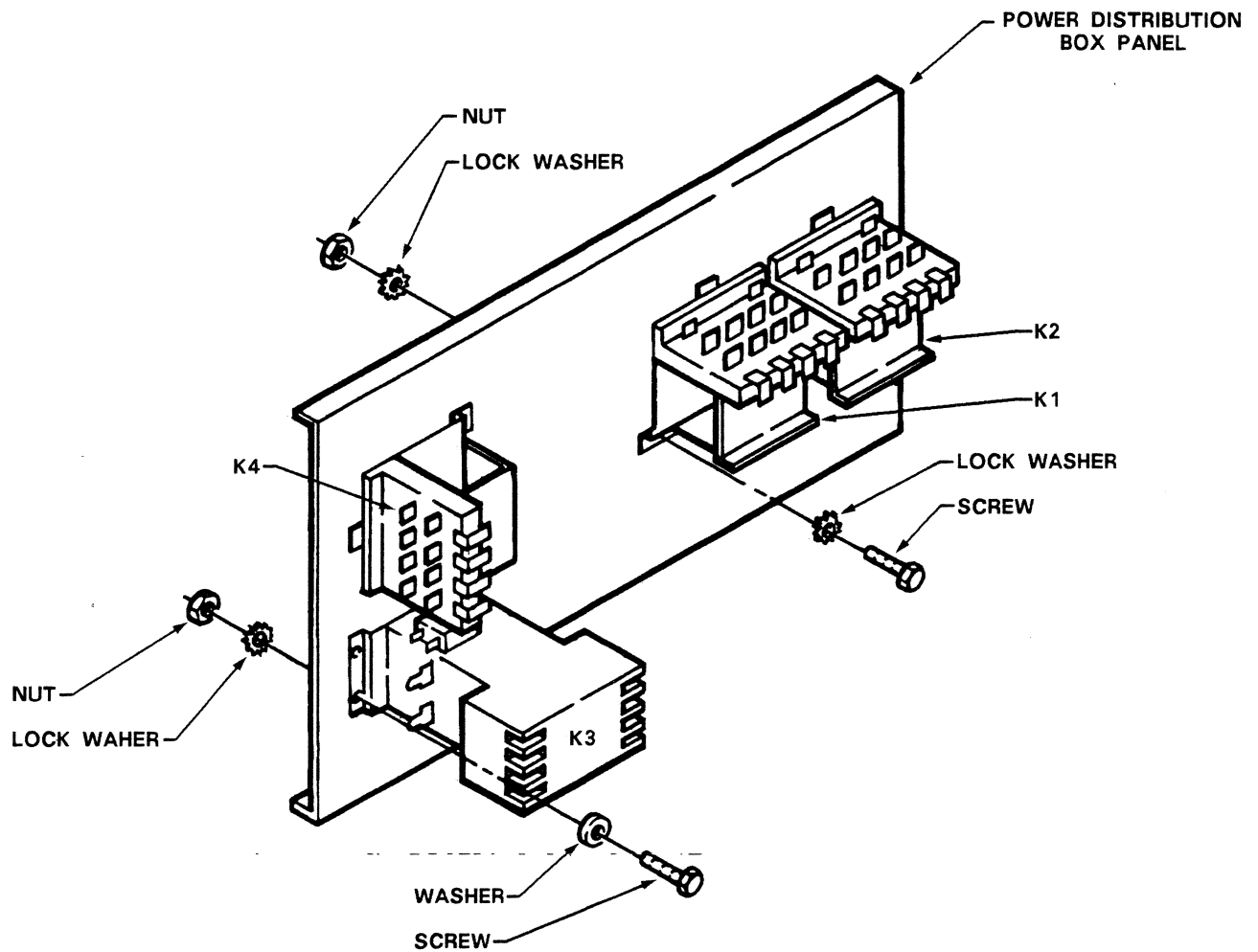
Relays A4K1, A4K2 (not contained in AT478-B), A4K3, and A4K4 mount on a panel within the power distribution box.

Tools/parts required

- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set
- Torque wrench 16.5 N·m (150 lbf·in), CDC P/N 12210926

Removal

- ___ 1. Remove power to the cabinet containing the faulty relay according to IOU Power Removal/Application.
- ___ 2. Unfasten screws and remove power distribution box top and left-side metal screen. If replacing either A4K3 or A4K4, unfasten screws and remove power distribution box back.
- ___ 3. Unfasten screws and remove sheet metal top and left-side wire screen.
- ___ 4. Remove screws securing T5 and mounting plate to angle bracket. Slide T5 aside.
- ___ 5. Label wires and remove them from terminals of faulty relay.
- ___ 6. Unfasten and remove screws, lock washers, and nuts securing relay (figure 5-24). Remove relay.



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Figure 5-24. Relay Installation

Replacement

- ___ 1. Perform steps of removal procedure in reverse order with following exceptions:
 - ___ a. K1, K2, and K4 - Torque nuts to 1.92 N·m (17.00 lbf·in).
 - ___ b. K3 - Torque nuts to 1.7 N·m (15.0 lbf·in).

Power Distribution Box Rectifier Removal/Replacement

Use this procedure to remove/replace rectifier A4CR1 located on the left-side, bottom rear of the power distribution box interior.

Tools/parts required

- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set

Removal

- ___ 1. Remove power to the cabinet containing the faulty rectifier according to IOU Power Removal/Application.
- ___ 2. Unfasten and remove power distribution box left-side end screen.
- ___ 3. Label wires on A4CR1 according to plus and minus connections and disconnect each.
- ___ 4. Remove screws securing A4CR1 to floor of power distribution box and remove rectifier.

Replacement

Perform steps of removal procedure in reverse order.

Power Distribution Box Rotary Switch Removal/Replacement

Use this procedure to remove/replace rotary switches A4S1 and A4S2 mounted on the front panel of the power distribution box.

Tools/parts required

- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set
- Allen wrench set

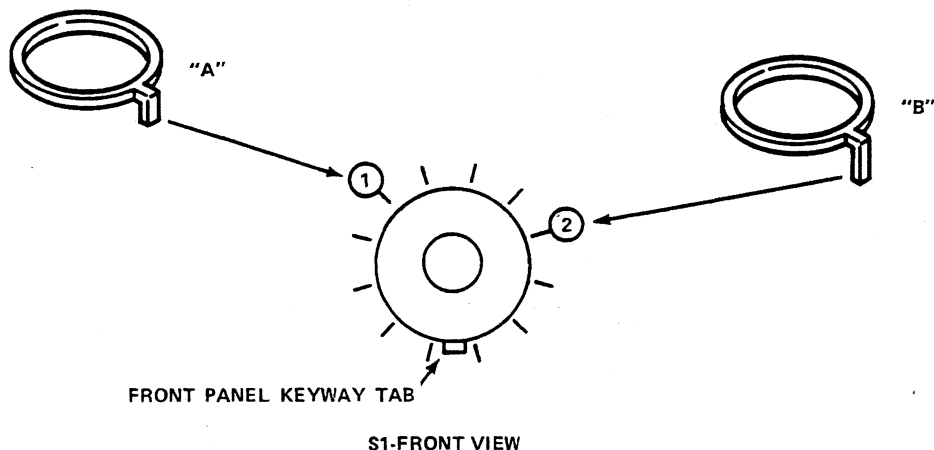
Removal

- ___ 1. Remove power to the cabinet containing the faulty rectifier according to IOU Power Removal/Application.
- ___ 2. Remove power distribution box from cabinet according to Power Distribution Box Removal/Replacement.
- ___ 3. Unfasten screws and remove power distribution box top.
- ___ 4. Label wires and disconnect them from faulty rotary switch.
- ___ 5. Loosen Allen-head setscrew and remove rotary switch knob from shaft.
- ___ 6. Unfasten and remove hex nut and washer from rotary switch shaft.
- ___ 7. Remove faulty switch.

Replacement

- ___ 1. Remove nut and lock washer from switch front shaft.

- ___ 2. Reposition rings as follows (figure 5-25).
 - a. Position ring A (supplied) so that tab locks into location 1.
 - b. Adjust front shaft of switch to counterclockwise stop.
 - c. Position ring B (supplied) so that tab locks into location 2.



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Figure 5-25. A4S1 Switch Orientation and Mechanical Stops

- ___ 3. Orient switch with keyway tab down and insert switch into mounting hole.
- ___ 4. Fasten switch with hex nut and washer.
- ___ 5. Attach labeled wires to switch terminals.
- ___ 6. Replace power distribution box top.
- ___ 7. Replace rotary switch knob.
- ___ 8. Replace power distribution box in cabinet according to Power Distribution Box Removal/Replacement.

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Power Distribution Box Power Warning Board Removal/Replacement

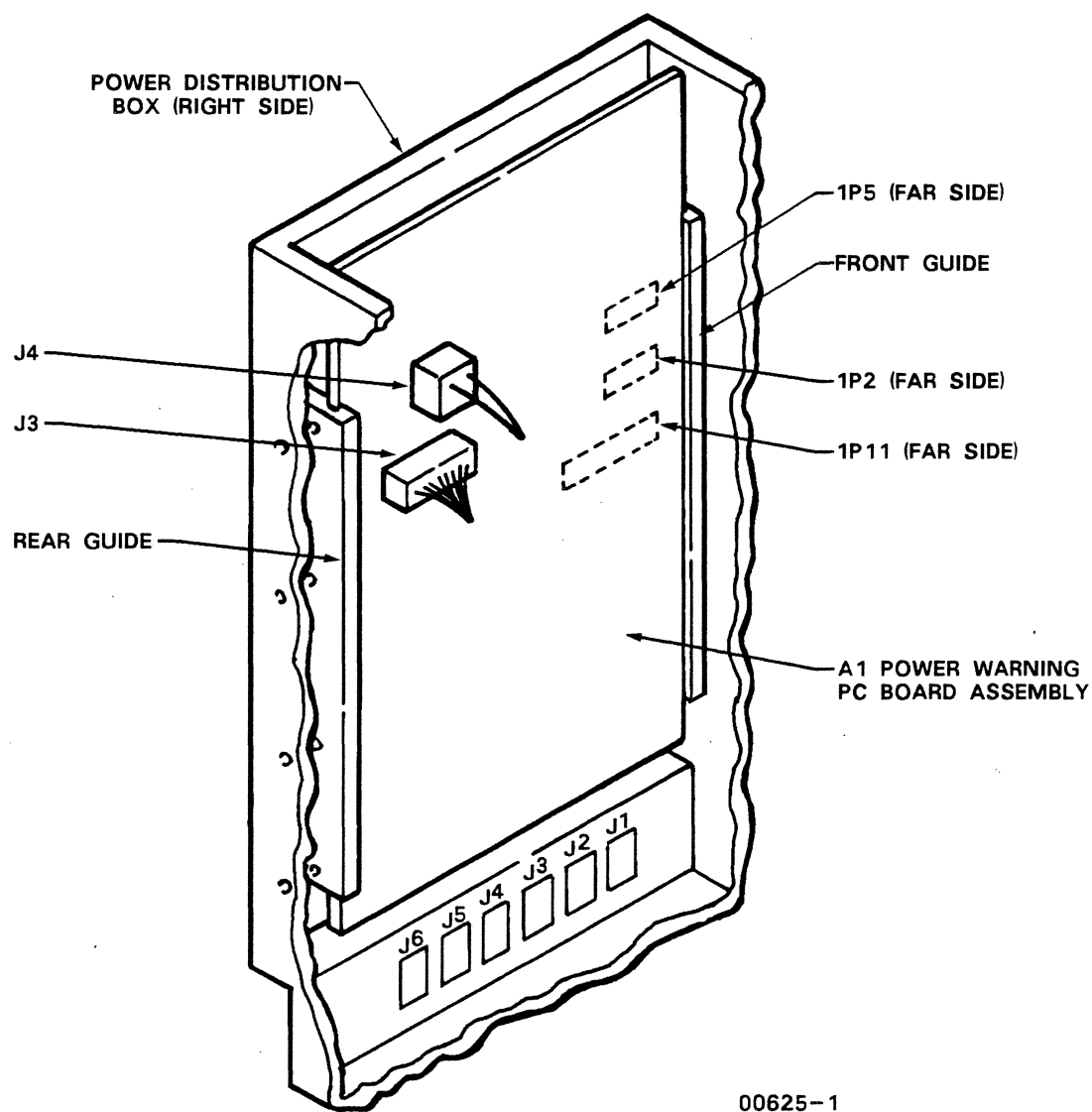
The power warning board contains the components and circuits for power-on and power-off sequencing and the indicators for faults and warnings. The board assembly mounts inside the power distribution box.

Tools/parts required

- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set

Removal

- ___ 1. Remove power to the cabinet containing the faulty power warning board according to IOU Power Removal/Application.
- ___ 2. Unfasten screws and remove power distribution box top.
- ___ 3. From inside power distribution box, disconnect and remove plugs from connectors J3 and J4 on logic module (figure 5-26).
- ___ 4. From outside power distribution box on right side, disconnect and remove plugs from logic module connectors 1P2, 1P5, and 1P11, pulling plugs and wiring through opening in side of power distribution box.
- ___ 5. Remove logic module by pulling straight up so that board does not jam in card guides.



00625-1

Figure 5-26. Power-Warning Printed Circuit Board Installation

Replacement

Perform steps of removal procedure in reverse order.

Thermostat Removal/Replacement

Use this procedure to remove/replace the thermostats 1S1 or 1S2 located on the top of the power heat sink to either side of transformer 1T3.

Tools/parts required

- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set
- Soldering iron
- Brillo pad
- Thermal grease (GE641), CDC P/N 94657900

Removal

- ___ 1. Remove power to the cabinet containing the faulty thermostat according to IOU Power Removal/Application.
- ___ 2. Unsolder and remove two wires from faulty thermostat terminals (figure 5-27).
- ___ 3. Remove screws and washers securing thermostat to heat sink and set faulty device aside.

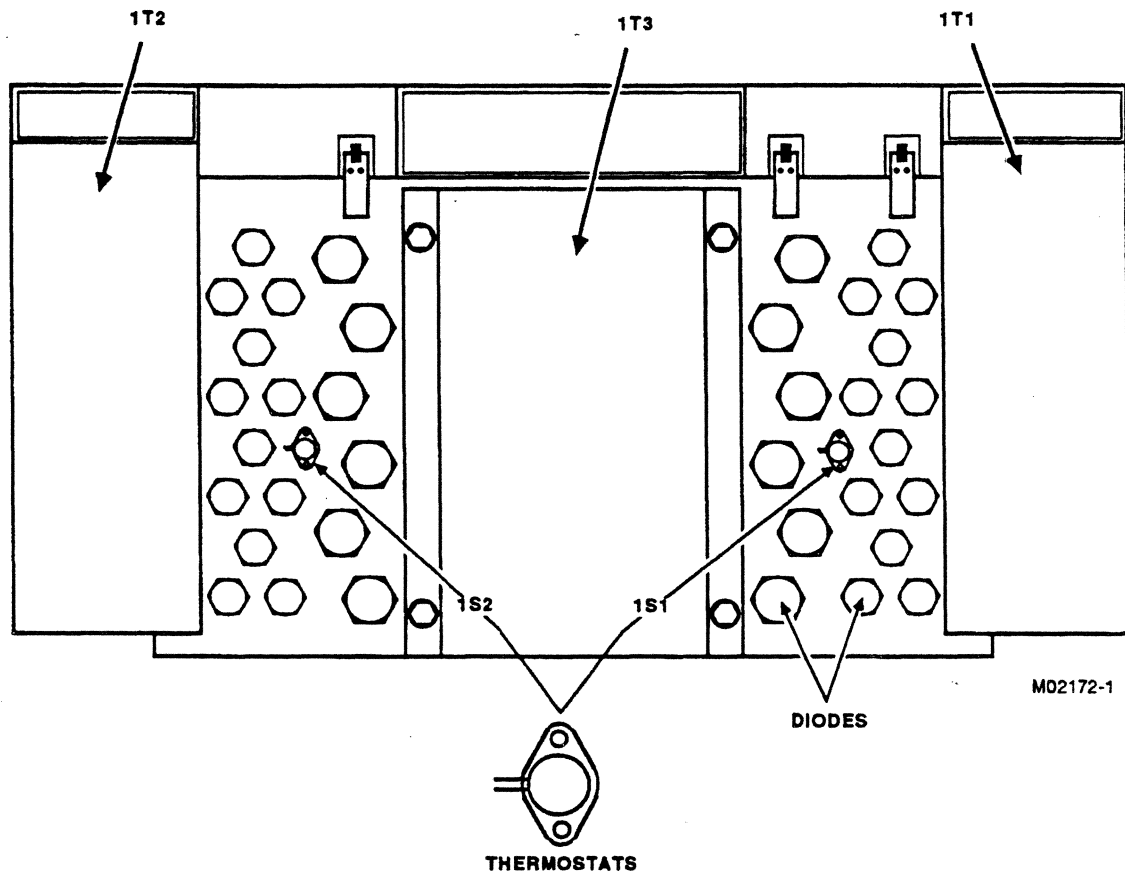


Figure 5-27. 1S1 and 1S2 Thermostats

Replacement

- ___ 1. Clean underside of thermostat and heat sink contact area with Brillo pad.
- ___ 2. Apply thermal grease to underside of thermostat.
- ___ 3. Fasten thermostat to heat sink with screws and washers.
- ___ 4. Solder wires to thermostat terminals and slide sleeving over terminals.

Temperature Sensor Removal/Replacement

Use this procedure to remove/replace the temperature sensors 1TS1, 1TS2, 1TS3, or 1TS4. Sensors 1TS1, 1TS2, and 1TS3 are located on the top of the power heat sink to either side of transformer 1T3. Sensor 1TS4 is located at the top right-hand corner of the power distribution box.

Tools/parts required

- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set

Removal

- ___ 1. Remove power to the cabinet containing the faulty temperature sensor according to IOU Power Removal/Application.
- ___ 2. Perform either step 3 to remove 1TS1, 1TS2, or 1TS3, or step 4 to remove 1TS4.
- ___ 3. The three temperature sensors are accessible from the rear of the cabinet, and can be removed by performing substeps a and b (figure 5-28).
 - ___ a. Remove screws securing temperature sensor spacer and temperature sensor to heat sink.
 - ___ b. Pull assembly clear of chassis and disconnect cable plug from temperature sensor.
- ___ 4. Temperature sensor 1TS4 is accessible from the front of the cabinet, and can be removed by performing substeps a through c (figure 5-29).
 - ___ a. Slide sensor protect cover clear of temperature sensor (engages standoffs).
 - ___ b. Remove two screws and washers securing temperature sensor to standoffs.
 - ___ c. Pull assembly clear of chassis and disconnect cable plug from temperature sensor.

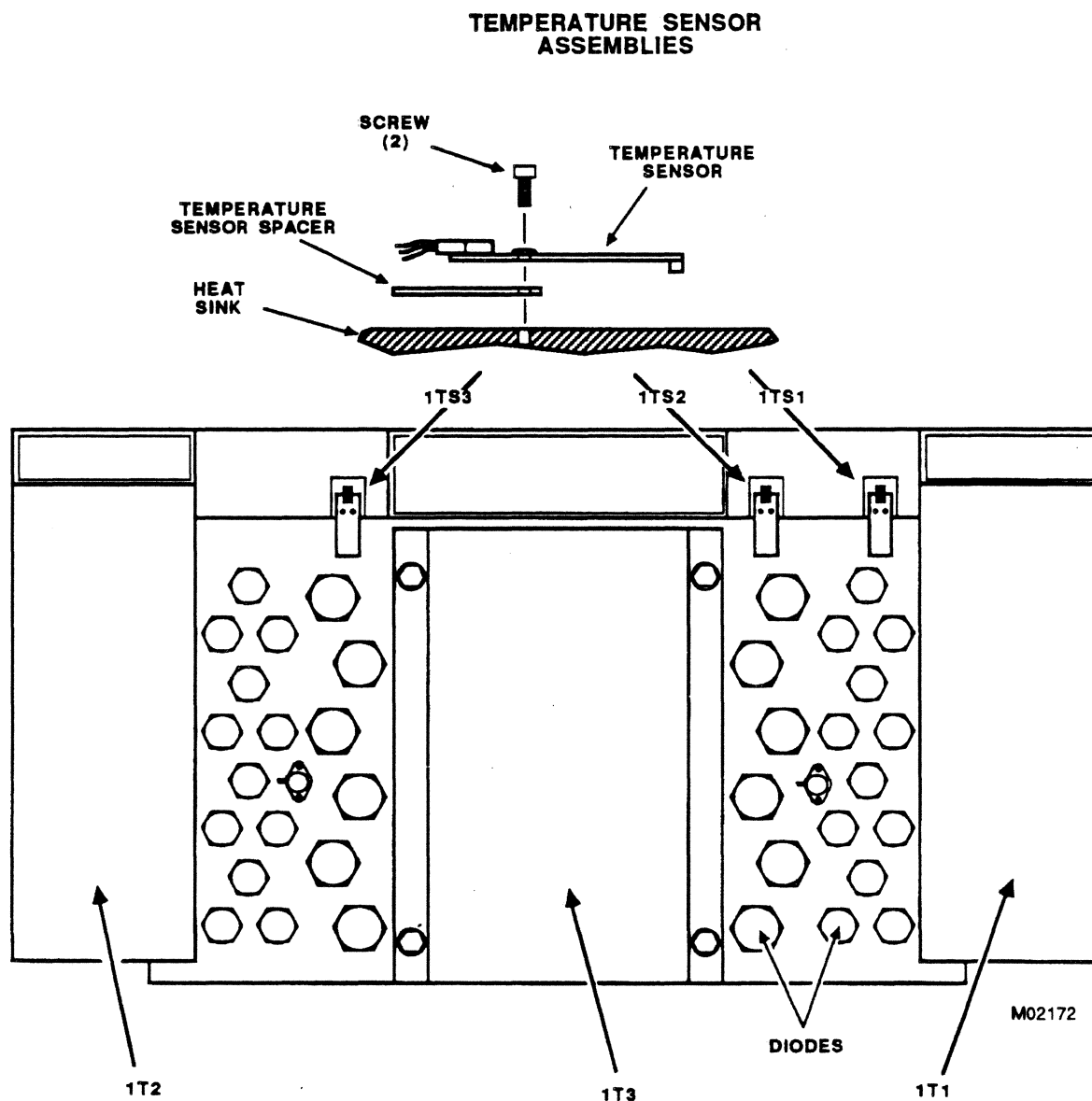


Figure 5-28. 1TS1, 1TS2, and 1TS3 Temperature Sensors

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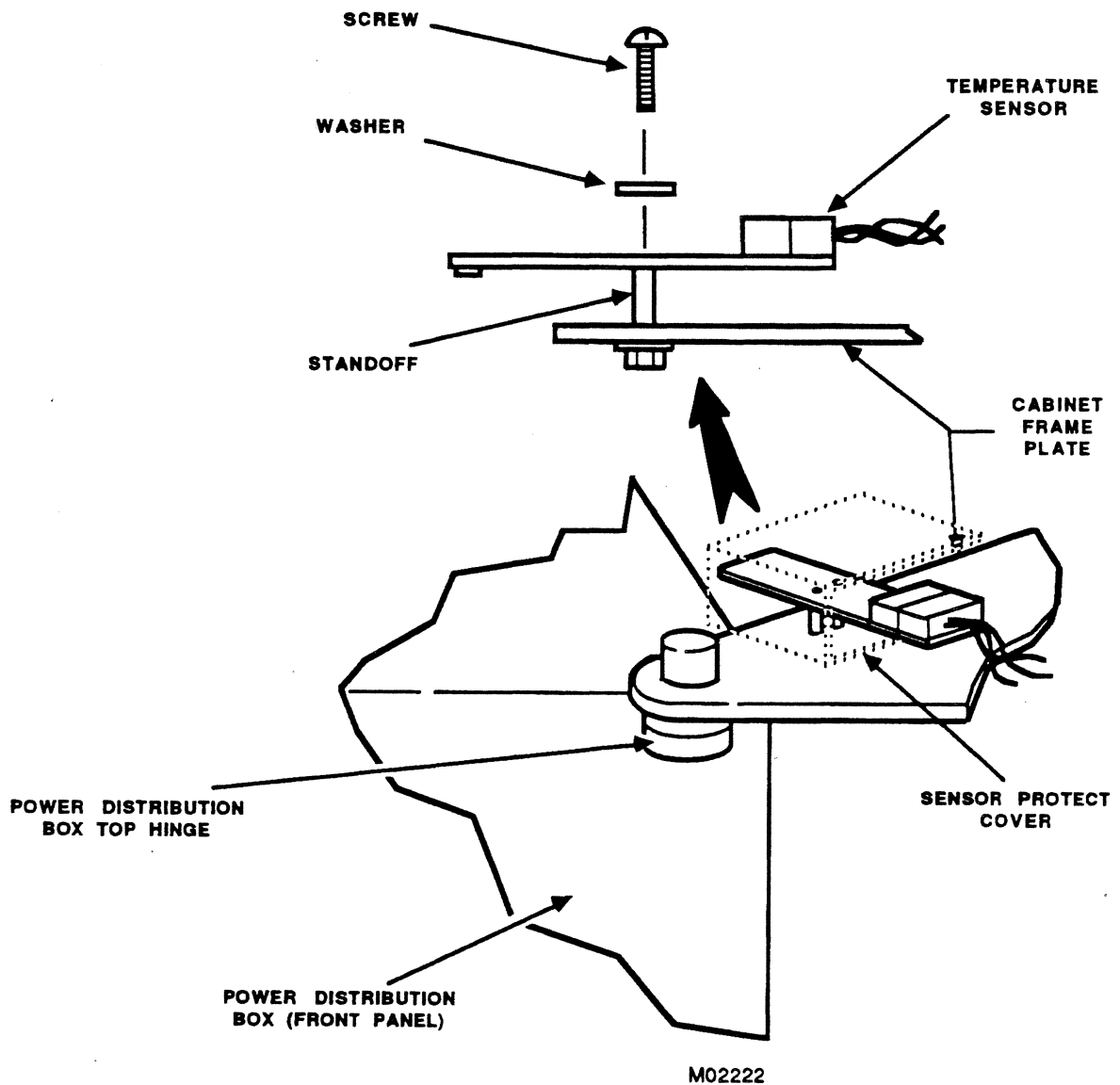


Figure 5-29. 1TS4 Temperature Sensor

Replacement

Perform steps of removal procedure in reverse order.

NOTE

Ensure that temperature sensor tip on 1TS1, 1TS2, or 1TS3 is firmly in contact with heat sink at completion of replacement.

Power Supply SCR Removal/Replacement

Three silicon controlled rectifiers (SCRs), 1CR37 (not used on AT478-B), 1CR38, and 1CR39 provide transient protection for the circuits from potentially harmful voltage or current overloads. During an overload, the SCRs instantly short their associated power buses to ground while slower reacting contactors remove power from the voltage bus. The SCRs are accessible from the rear of the cabinet and are located just above the large transformers on the cabinet base heat sink.

Tools/parts required

- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set
- Adjustable wrench
- 1-1/16-in open end wrench
- 1-1/8-in open end wrench
- Scotch Brite
- Thermal grease (GE641), CDC P/N 94657900
- 1-1/8-in socket
- Torque wrench 113 N·m (1000 lbf·in), CDC P/N 12205640

Removal

- ___ 1. Remove power from cabinet containing faulty SCR according to IOU Power Removal/Application.
- ___ 2. Label, unscrew, and remove small red and white wires from faulty SCR at 1TB1 or 1TB2, as applicable, on ground grid plate.
- ___ 3. Loosen and remove bolt, washers, and nut (if used) securing SCR flexible power lead to transformer center tap bar or ground grid plate (1CR37), as applicable.
- ___ 4. Loosen and remove locking nut from SCR stud bolt with 1-1/16-in open end wrench. Use adjustable wrench on SCR body to prevent it from turning.
- ___ 5. Remove mounting nut from SCR stud bolt using 1-1/8-in open end wrench.
- ___ 6. Remove SCR.

Replacement

- ___ 1. Clean contact surface on ground grid plate or red bus, as applicable, with Scotch Brite.
- ___ 2. Apply thin layer of thermal grease to underside of base and threads of SCR.
- ___ 3. Insert SCR through hole in ground grid plate or red bus, as applicable, and screw mounting nut onto SCR stud bolt by hand.
- ___ 4. Hold SCR body with adjustable wrench while using torque wrench and 1-1/8-in socket to tighten mounting nut as follows:
 - ___ a. 1CR37 to 4.5 N·m (40 lbf·in)
 - ___ b. 1CR38/39 to between 34 and 39 N·m (300 and 360 lbf·in)
- ___ 5. Install locking nut.
- ___ 6. Secure SCR flexible lead as follows:
 - ___ a. Attach 1CR37 flexible power lead to ground grid plate with Torx-head screw, and torque screw to 7.4 N·m (65 lbf·in).
 - ___ b. Attach 1CR38/39 flexible power lead securely to transformer center tap using bolt, washer, and nut.
- ___ 7. Connect SCR's small red and white wires to terminal board 1TB1 or 1TB2, as applicable, on ground grid plate.

Bus Filter Capacitor Removal/Replacement

Use this procedure to replace bus filter capacitors C1 through C20 (C1, C6, C7, and C12 through C20 for AT478-B). The capacitors are accessed through the rear of the cabinet.

Tools/parts required

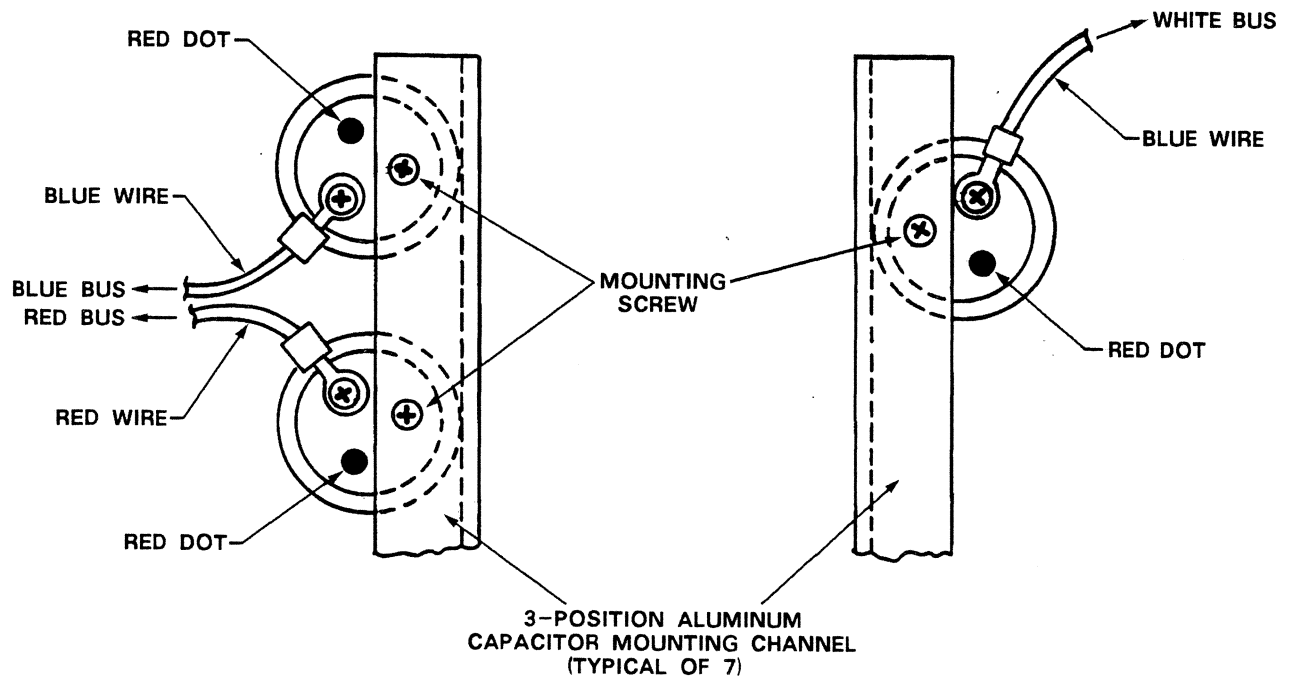
- Phillips screwdriver
- Flat-blade screwdriver
- 3/8-in socket set

Removal

- ___ 1. Remove power from cabinet containing faulty capacitor according to IOU Power Removal/Application.
- ___ 2. Observe polarity of capacitor connection.
- ___ 3. Pull back rubber terminal cover. Unscrew and remove screw and washer that attach capacitor lead to red, white, or blue bus bar (figure 5-30).
- ___ 4. Unscrew and remove screw and washer that attach capacitor to bracket. Remove capacitor.

Replacement

Perform steps of removal procedure in reverse order.



NOTE:

RUBBER TERMINAL COVERS NOT SHOWN.

Figure 5-30. Filter Capacitor Mounting

Two-Port Multiplexer Power Supply Removal/Replacement

NOTE

This procedure does not apply to an AT481-B cabinet.

The two-port multiplexer (TPM) power supply provides power (+5 V, +12 V, and -12 V) for the TPM logic module. The power supply mounts alongside the logic cage in an AT478-B cabinet and is accessed from the front of the cabinet. The supply provides overcurrent and overvoltage protection to the circuits in the TPM.

Tools/parts required

- 3/8-in socket set

Removal

- ___ 1. Remove power from cabinet containing faulty TPM power supply according to IOU Power Removal/Application.
- ___ 2. Disconnect four connectors at top of TPM power supply.
- ___ 3. Remove nuts and washers from studs protruding from underside of shelf supporting TPM power supply.
- ___ 4. Raise TPM power supply until studs clear supporting shelf, and pull assembly clear of chassis.

Replacement

- ___ 1. Perform steps of removal procedure in reverse order.
- ___ 2. Perform IOU Two-Port Multiplexer Power Supply Adjustment procedure.

Power Input Box Filter Removal/Replacement

The power input box of each cabinet contains two power line filters; FL1 for 50/60-Hz, and FL2 for 400-Hz. The power input box is accessed from the front of the cabinet and is located below the IOU cabinet connector panel.

Tools/parts required

- 3/8-in socket set
- Flat-blade screwdriver
- Phillips screwdriver

Removal

- ___ 1. Remove power from the cabinet containing the faulty line filter according to IOU Power Removal/Replacement.
- ___ 2. Remove Torx-head screws securing power input box cover. Set cover aside.
- ___ 3. Disconnect leads to filter as follows:
 - ___ a. FL1 - disconnect Faston connections.
 - ___ b. FL2 - remove screws and washers that connect leads.
- ___ 4. Remove Torx-head screws securing line filter to back of power input box. Remove filter.

Replacement

Perform steps of removal procedure in reverse order.

Cabinet Blower Assembly Removal/Replacement

Use this procedure when replacing the blower assembly in the top of an IOU cabinet.

Tools/parts required

- 3/8-in socket set
- Flat-blade screwdriver

Removal

1. Remove power from cabinet containing blower assembly to be replaced according to IOU Power Removal/Application.

CAUTION

Blower assembly top cover on an IOU cabinet consists of two sections. Part containing grill work must be removed first so that temperature sensor and airflow sensor are not damaged.

2. Remove Torx-head screws from outer edge of blower assembly top cover section that contains grill work (figure 5-31).
3. Raise top cover clear of cabinet and set it aside.
4. Remove Torx-head screws from outer edge of other part of top cover, raise it clear of cabinet, and set it aside.
5. Note blower motor lead wire connection scheme at adjacent terminal strip. Disconnect lead wires at terminal strip.
6. Remove Torx-head screws and nut/washers securing blower assembly to cabinet bulkhead.

Replacement

1. Secure replacement blower assembly to cabinet bulkhead.
2. Connect three blower motor lead wires to adjacent terminal strip.

CAUTION

Do not contact temperature sensor and/or airflow sensor with blower assembly top cover. Devices may be damaged.

- 3. Place blower assembly top cover that does not contain grill work atop cabinet half containing blower motor. Secure it in place with Torx-head screws.
- 4. Place blower assembly top cover that contains grill work atop other half of cabinet and secure in place with Torx-head screws.

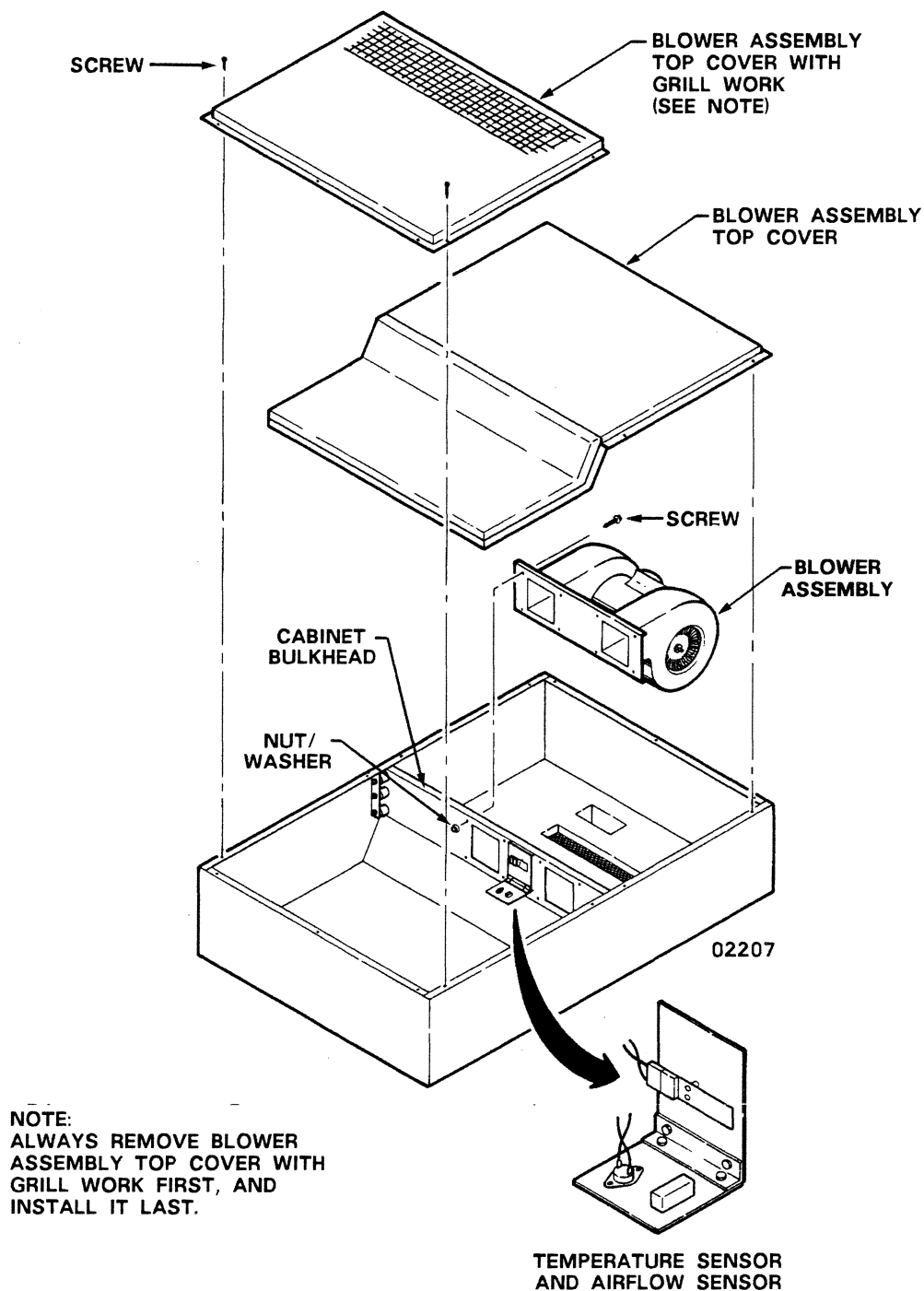


Figure 5-31. Cabinet Blower Assembly

Sensor Assembly Removal/Replacement

Use this procedure to remove/replace the sensor assembly containing the airflow sensor and temperature sensor. The sensor assembly is located in the cabinet blower chamber at the top of the cabinet.

Tools/parts required

- 3/8-in socket set

Removal

1. Remove power to cabinet containing faulty sensor assembly according to IOU Power Removal/Application.

⚠ CAUTION

Blower assembly top cover on an IOU cabinet consists of two sections. Part containing grill work must be removed first so that temperature sensor and airflow sensor are not damaged.

2. Remove Torx-head screws from outer edge of blower assembly top cover section that contains grill work (figure 5-32).
3. Raise top cover clear of cabinet and set it aside.
4. Remove Torx-head screws from outer edge of other part of top cover, raise it clear of cabinet, and set it aside.
5. Disconnect sensor assembly cable plug from mating receptacle.
6. Remove Torx-head screws securing sensor assembly to cabinet bulkhead. Set faulty device aside.

Replacement

1. Secure replacement sensor assembly to cabinet bulkhead with Torx-head screws.
2. Connect sensor assembly cable plug to mating receptacle on cabinet bulkhead.

⚠ CAUTION

Do not contact temperature sensor and/or airflow sensor with blower assembly top cover. Devices may be damaged.

- 3. Place blower assembly top cover that does not contain grill work atop cabinet half containing blower motor. Secure it in place with Torx-head screws.
- 4. Place blower assembly top cover that contains grill work atop other half of cabinet and secure in place with Torx-head screws.

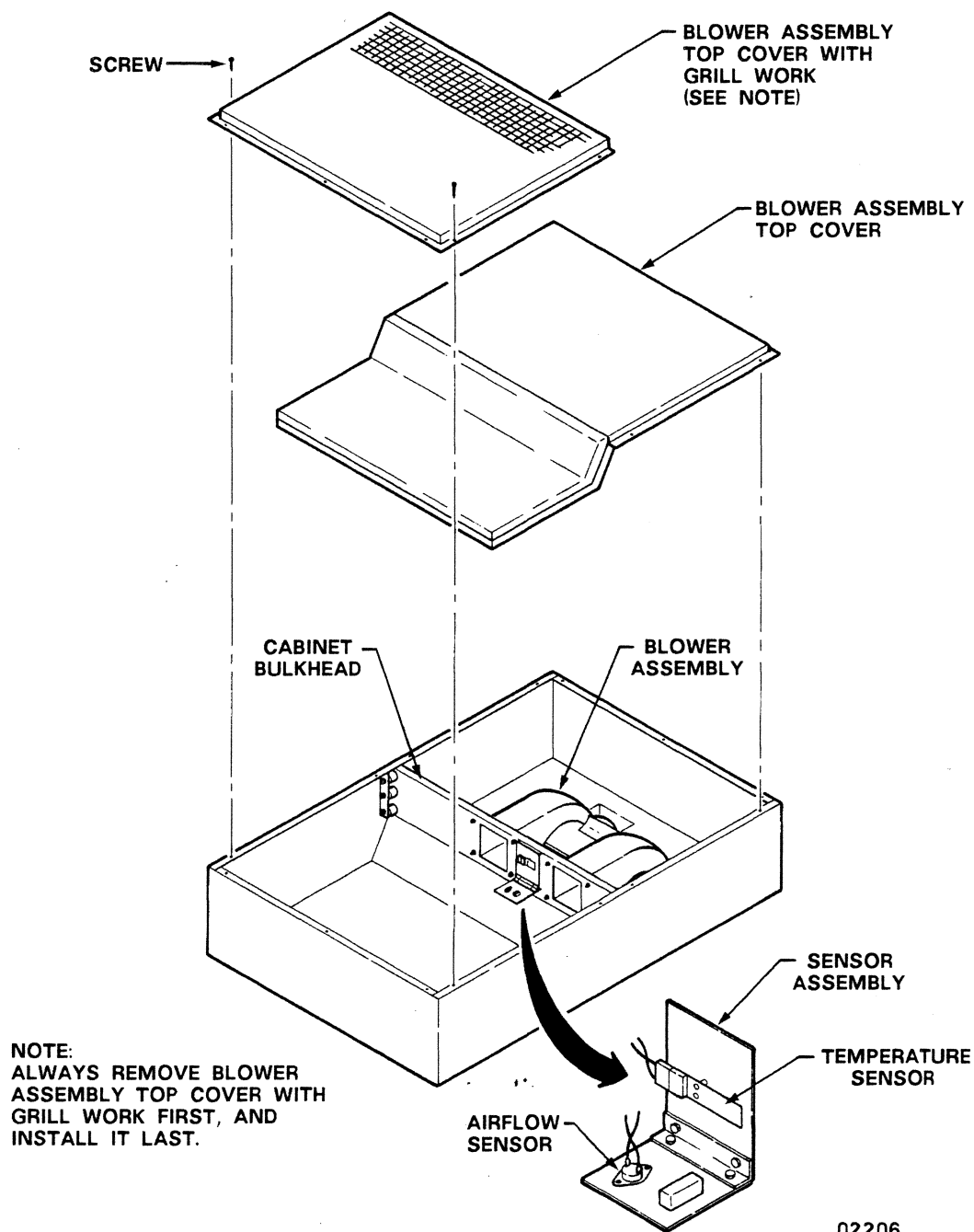


Figure 5-32. Sensor Assembly

IOU Cabinet Bus Voltage Adjustment

Use this procedure to adjust the voltage levels and the metering in a power distribution box of an IOU cabinet. Refer to figure 5-33 while performing this procedure.

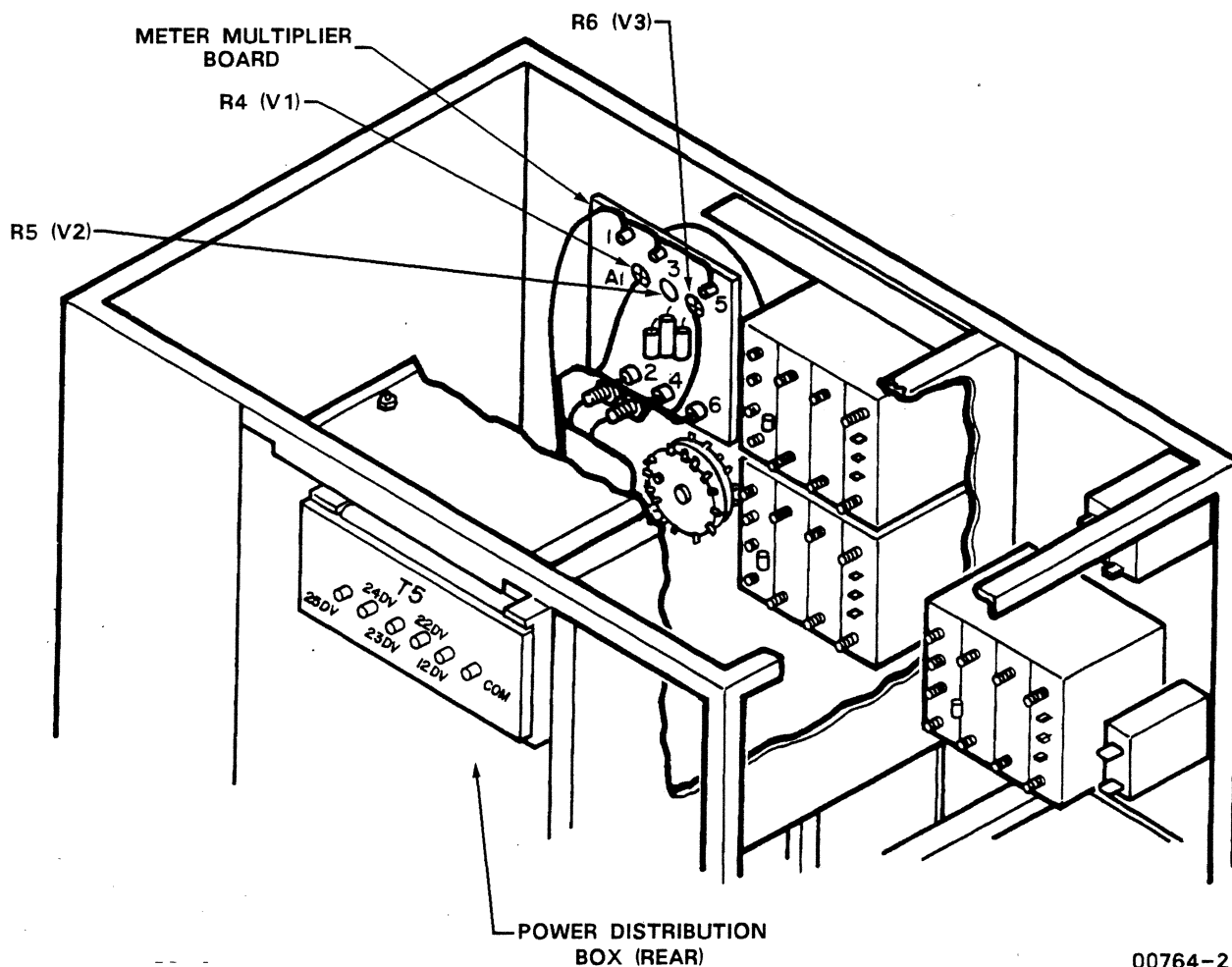
Tools/parts required

- Slotted screwdriver
- Digital multimeter (Fluke 8020A), CDC P/N 12263279

Procedure

- ___ 1. Set site 50/60-Hz wall-mounted circuit breaker for IOU to be adjusted to ON.
- ___ 2. Set site 400-Hz wall-mounted circuit breaker for IOU to be adjusted to OFF.
- ___ 3. Set controls on power distribution box of IOU to be adjusted as follows:
 - ___ a. All Vx DISCONNECT, 50/60 Hz DISCONNECT, and MAIN DISCONNECT circuit breakers to OFF.
 - ___ b. All Vx ADJUST knobs fully counterclockwise.
 - ___ c. LOC/REM switch to LOC.
- ___ 4. Unfasten screws and remove top from power distribution box to be adjusted.
- ___ 5. Set site 400-Hz wall-mounted circuit breaker for IOU to be adjusted to ON.
- ___ 6. Apply power sequentially at power distribution box of IOU being adjusted as follows:
 - ___ a. V1 DISCONNECT circuit breaker to ON.
 - ___ b. V2 DISCONNECT circuit breaker to ON.
 - ___ c. Does not apply to AT478-B: V3 DISCONNECT circuit breaker to ON.
 - ___ d. MAIN DISCONNECT circuit breaker to ON.
 - ___ e. Press RESET switch.
- ___ 7. Listen for sound of air circulating in cabinet to ensure that its blower assembly is operating.
- ___ 8. Check percentage meter mechanical zero as follows:
 - ___ a. Set power distribution box METER SELECT switch to OFF.
 - ___ b. Observe that meter needle rests on left indicator line. If necessary, adjust needle to line with screw on front of meter.

- ___ 9. Connect multimeter to power distribution box EXTERNAL METER test points.
- ___ 10. Adjust voltage V1 as follows:
 - ___ a. Set METER SELECT switch to V1.
 - ___ b. Turn V1 ADJUST knob slowly clockwise until multimeter reads V1 voltage written on NOMINAL VOLTAGE label.
 - ___ c. Adjust potentiometer R4 on meter multiplier board until power distribution box percentage meter indicates 0 percent.



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Figure 5-33. Meter Multiplier Board Adjustment Potentiometers

- ___ 11. Adjust voltage V2 as follows:
 - ___ a. Set METER SELECT switch to V2.
 - ___ b. Turn V2 ADJUST knob slowly clockwise until multimeter reads V2 voltage written on NOMINAL VOLTAGE label.
 - ___ c. Adjust potentiometer R5 on meter multiplier board until power distribution box percentage meter indicates 0 percent.
- ___ 12. Adjust voltage V3 as follows (applicable to AT481-B only):
 - ___ a. Set METER SELECT switch to V3.
 - ___ b. Turn V3 ADJUST knob slowly clockwise until multimeter reads V3 voltage written on NOMINAL VOLTAGE label.
 - ___ c. Adjust potentiometer R6 on meter multiplier board until power distribution box percentage meter indicates 0 percent.
- ___ 13. Disconnect multimeter.
- ___ 14. Set LOC/REM switch to REM.

NOTE

The AT478-B does not contain a +5 V ac bus. When METER SELECT switch is set to V3, power distribution box percentage meter measures +5 V dc output of TPM power supply.

- ___ 15. Adjust percentage meter as follows (applicable to AT478-B only):
 - ___ a. Perform IOU Two-Port Multiplexer Power Supply Adjustment procedure.
 - ___ b. Set METER SELECT switch to V3.
 - ___ c. Adjust potentiometer R6 on meter multiplexer board until power distribution box percentage meter indicates 0 percent.

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IOU Two-Port Multiplexer Power Supply Adjustment

Use this procedure to adjust the +5 V output voltage of the two-port multiplexer (TPM) power supply. The TPM power supply mounts alongside the logic chassis in an AT478-B cabinet and is accessed from the front of the cabinet.

NOTE

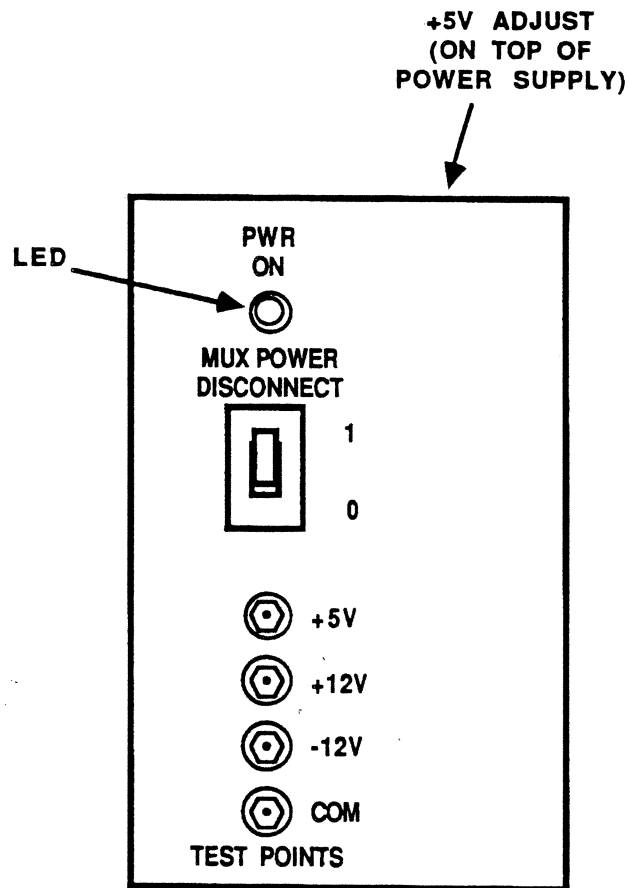
This procedure does not apply to an AT481-B cabinet.

Tools/parts required

- Insulated adjustment tool
- Digital multimeter (Fluke 8020A), CDC P/N 12263279

Procedure

- ___ 1. Set controls on power distribution box of IOU to be adjusted as follows:
 - ___ a. LOC/REM switch to LOC.
 - ___ b. MAIN DISCONNECT and 50/60 Hz DISCONNECT circuit breakers to ON.
- ___ 2. Set site 50/60-Hz wall-mounted circuit breaker for IOU to be adjusted to ON.
- ___ 3. Set site 400-Hz wall-mounted circuit breaker for IOU to be adjusted to ON.
- ___ 4. Set MUX POWER DISCONNECT circuit breaker on TPM power supply (figure 5-34) to ON, up position. Power supply PWR ON indicator lights.
- ___ 5. Connect multimeter to COM and +5 V test points on TPM power supply.
- ___ 6. Use insulated adjustment tool to turn +5 V ADJUST on top of TPM power supply until multimeter indicates +5.01 V.
- ___ 7. Disconnect multimeter.
- ___ 8. Set LOC/REM switch to REM.



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Figure 5-34. Two-Port Multiplexer Power Supply

IOU Cabinet Margin Tests

The margin tests verify that the bus voltage adjustment range is within ± 5 percent of the nominal voltage.

Tools/parts required

- Digital multimeter (Fluke 8020A), CDC P/N 12263279

Procedure

- ___ 1. Set controls on power distribution box of IOU being checked as follows:
 - ___ a. LOC/REM switch to LOC.
 - ___ b. All V_x DISCONNECT, 50/60 Hz DISCONNECT, and MAIN DISCONNECT circuit breakers to ON.
- ___ 2. Connect multimeter to power distribution box EXTERNAL METER test points.
- ___ 3. Select bus to be checked with METER SELECT switch.
- ___ 4. Turn ADJUST knob for selected bus counterclockwise until multimeter indicates lower margin voltage specified in table 5-1 for selected bus.
- ___ 5. Repeat steps 3 and 4 for remaining buses.
- ___ 6. Turn V_x ADJUST knob for selected bus clockwise until multimeter indicates upper margin voltage specified in table 5-1 for selected bus.
- ___ 7. Repeat step 6 for remaining buses.
- ___ 8. Return each bus voltage level to voltage value written on NOMINAL VOLTAGE label.
- ___ 9. Set LOC/REM switch to REM.

Table 5-1. Bus Voltage Margins

Bus	Lower Margins (V dc)	Upper Margins (V dc)
V1	-2.090	-2.310
V2	-4.940	-5.460
V3 ¹	+4.750	+5.250

Note:

1. Not applicable to AT478-B.

Ripple Voltage Test

Use this procedure to measure ripple voltage on the buses of an IOU cabinet. The buses are accessed from the rear of the cabinet. Test points listed in tables 5-2 and 5-3 are marked on the related bus.

Tools/parts required

- Oscilloscope (Tektronix 2465 with option 11), CDC P/N 12263632

Procedure

1. Connect oscilloscope to each point listed in either table 5-2 or 5-3, as appropriate, and ensure that displayed peak-to-peak ripple voltage does not exceed specified value.
2. Replace SCR associated with any bus displaying excessive ripple. (Refer to Power Supply SCR Removal/Replacement procedure.)

Table 5-2. AT478-B Cabinet Bus Ripple Voltage

Logic Cage	Measuring Point	Peak-To-Peak Maximum Ripple (mV)
1A2-A1 (Upper Row)	White Bus, E1	30
	Blue Bus, E1	60
1A2-A2 (Lower Row)	White Bus, E6	30
	Blue Bus, E6	60

Table 5-3. AT481-B Cabinet Bus Ripple Voltage

Logic Cage	Measuring Point	Peak-To-Peak Maximum Ripple (mV)
1A2-A1 (Upper Row)	White Bus, E1	30
	Blue Bus, E1	60
	Red Bus, E5	60
	White Bus, E6	30
1A2-A2 (Lower Row)	Blue Bus, E6	60
	Red Bus, E11	60

Diode Waveform Checks

Use this procedure to perform diode waveform checks on the power diodes associated with transformers 1T1, 1T2, and 1T3. Refer to figures 5-35 and 5-36 while performing this procedure.

NOTE

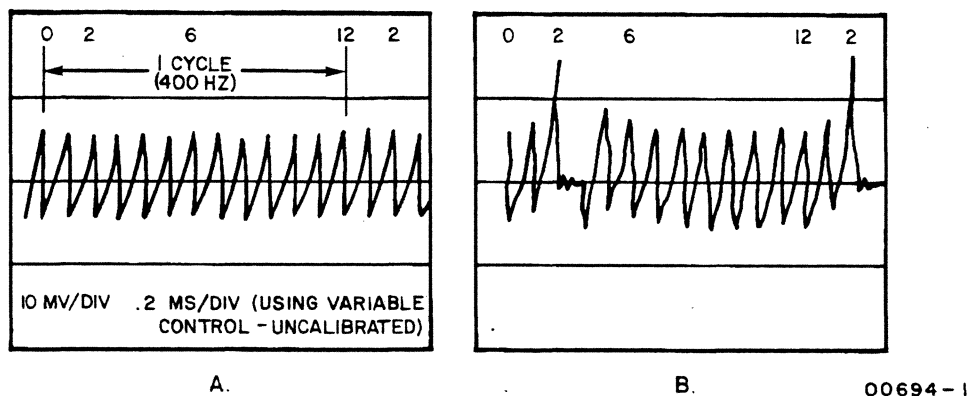
An AT478-B cabinet does not contain transformer 1T2.

Tools/parts required

- Oscilloscope (Tektronix 2465 with option 11), CDC P/N 12263632

Procedure

- ___ 1. With power applied to cabinet, connect oscilloscope equipped with a 10X probe between the center tap bar of transformer 1T1, 1T2, or 1T3 (as appropriate) and cabinet chassis.
- ___ 2. Make oscilloscope connections/settings as follows:
 - ___ a. Synchronize externally to diode lead
 - ___ b. Set input coupling to ac
 - ___ c. Set sweep speed to -0.25 ms per division
- ___ 3. Display one complete 400-Hz rectification cycle (12 peaks) as shown in figure 5-35.

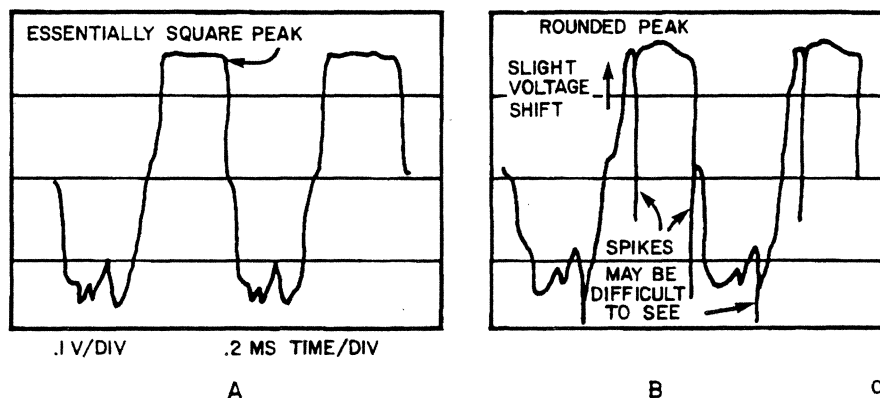


NOTE

ALL WAVEFORMS SHOWN HAVE VOLTAGE
TRACE SET ON CENTER LINE.

Figure 5-35. 400-Hz, 3-Phase Rectification Cycle Waveform

- ___ 4. Determine if waveform is normal or defective.
- ___ 5. If waveform is normal, repeat steps 1 through 4 for untested transformers and diodes.
- ___ 6. If waveform appears defective, make additional comparisons to waveforms in figure 5-36. If waveform still appears to be defective, perform Diode Balance Check procedure.



00694-2

NOTE

ALL WAVEFORMS SHOWN HAVE VOLTAGE TRACE SET ON CENTER LINE.

Figure 5-36. Power Diode Waveforms

Diode Balance Check

This check allows comparison of the performance of each power diode associated with a particular power transformer.

Tools/parts required

- Clamp-on ammeter, ac
- Oscilloscope (Tektronix 2465 with option 11), CDC P/N12263632
- Digital multimeter (Fluke 8020A), CDC P/N 12263279

Procedure

- ___ 1. With power applied to cabinet, connect an AC clamp-on ammeter to each diode of selected power transformer and record current reading.
- ___ 2. Compare readings to each other as follows:
 - ___ a. If all readings are within 20 percent of each other, diodes are functioning correctly. Repeat steps 1 and 2 for the remaining transformers.
 - ___ b. If readings differ by more than 20 percent, go to step 3.
- ___ 3. Using table 5-4 as a guide, start making measurements at 400-Hz input to the particular power supply. Test each component for ac ripple, working toward dc bus outputs until problem is located. If measured ripple greatly exceeds permissible limits, look for small imbalances in current and voltage readings.
- ___ 4. When area of trouble is located, eliminate the possibility of a bad connection, a bad wire, or a wiring error before replacing a component. Then remeasure ripple. If ripple is still high, return to a point before the trouble area and continue ripple measurements.

Table 5-4. Diode Troubleshooting Guide

Measurement	Equipment	Measure At
Transformer input voltages (ac)	Digital multimeter	Phase-to-phase
Bad connection or bad wire	Digital multimeter	Across connection or across opposite ends of wire
Diode forward voltage drop	Oscilloscope	Across diode
Current in diode	ac clamp-on ammeter	Diode lead
Transformer secondary voltage	Digital multimeter	Leg-to-leg

Transient Protect Test

Use the following procedure to test a cabinet's response to a momentary loss of input power.

Procedure

- ___ 1. With power applied to cabinet to be tested, set controls of power distribution box as follows:
 - ___ a. LOC/REM switch to LOC.
 - ___ b. All Vx DISCONNECT, 50/60 Hz DISCONNECT, and MAIN DISCONNECT circuit breakers to ON.
- ___ 2. Cabinet blower starts and power distribution box POWER ON indicator lights.
- ___ 3. Press and release TEST switch. Observe following:
 - ___ a. All Vx DISCONNECT circuit breakers trip to OFF.
 - ___ b. All Vx FAULT indicators light.
 - ___ c. POWER ON indicator goes out.
 - ___ d. Cabinet blower stops.
- ___ 4. Press and release RESET switch. Observe following:
 - ___ a. CIRCUIT BREAKER OFF/TRIP indicator lights.
 - ___ b. All Vx FAULT indicators go out.
- ___ 5. Set all Vx DISCONNECT circuit breakers to ON.
- ___ 6. Press and release RESET switch. Observe following:
 - ___ a. CIRCUIT BREAKER OFF/TRIP indicator goes out.
 - ___ b. POWER ON indicator lights.
 - ___ c. Cabinet blower starts.
- ___ 7. Set LOC/REM switch to REM.

Bus Voltage Error Detection

The following procedure checks a cabinet's response to out-of-limit bus voltages.

Tools/parts required

- Digital multimeter (Fluke 8020A), CDC P/N 12263279
- Clamp-on ammeter, dc

Procedure

- ___ 1. Set controls on power distribution box of cabinet being checked as follows:
 - ___ a. LOC/REM switch to LOC.
 - ___ b. All V_x DISCONNECT, 50/60 Hz DISCONNECT, and MAIN DISCONNECT circuit breakers to OFF.
- ___ 2. Remove all logic modules from cabinet according to Logic Module Removal/Replacement.
- ___ 3. Connect multimeter to power distribution box EXTERNAL METER test points.
- ___ 4. Connect dc ammeter clamp to white gate wire on SCR for bus being checked, table 5-5.
- ___ 5. Set METER SELECT switch to select bus being checked.
- ___ 6. Set all V_x DISCONNECT, 50/60 Hz DISCONNECT, and MAIN DISCONNECT circuit breakers to ON.
- ___ 7. Turn V_x ADJUST knob (for bus being checked) clockwise. Stop when either multimeter indicates maximum fault detect voltage in table 5-5 or V_x FAULT indicator lights.
- ___ 8. If maximum fault detect voltage in table 5-5 is reached and a fault is not detected, replace the cabinet's power distribution box according to Power Distribution Box Removal/Replacement procedure.

Table 5-5. Buses, SCRs, and Fault Levels

Bus	SCR	Fault Detect Voltage (Maximum)
-2.2 V dc, V1, white	1CR39	-2.6 ± 0.30 V dc
-5.2 V dc, V2, blue	1CR38	-6.0 ± 0.60 V dc
+5.0 V dc, V3, red ¹	1CR37	+5.8 ± 0.58 V dc

Note:

1. Not applicable to AT478-B.

- ___ 9. If Vx FAULT indicator lights, observe following:
 - ___ a. Multimeter indicates 0 volt.
 - ___ b. Vx DISCONNECT circuit breaker is off.
 - ___ c. DC ammeter indicates 0.15 ± 0.03 A.
 - ___ d. POWER ON indicator goes out.
- ___ 10. Turn Vx ADJUST (for bus just checked) counterclockwise to its approximate starting position (step 7).
- ___ 11. Press and release RESET switch. Observe following:
 - ___ a. Vx FAULT indicator goes out.
 - ___ b. CIRCUIT BREAKER OFF/TRIP indicator lights.
- ___ 12. Set Vx DISCONNECT circuit breaker (for bus just checked) to ON.
- ___ 13. Press and release RESET switch. Observe following:
 - ___ a. All faults clear.
 - ___ b. CIRCUIT BREAKER OFF/TRIP indicator goes out.
 - ___ c. POWER ON indicator lights.
- ___ 14. Turn Vx ADJUST knob (for bus just checked) until multimeter reads voltage written on NOMINAL VOLTAGE label for this bus.
- ___ 15. Set all Vx DISCONNECT, 50/60 Hz DISCONNECT, and MAIN DISCONNECT circuit breakers to OFF.
- ___ 16. Repeat steps 4 through 15 for remaining buses.
- ___ 17. Replace logic modules in cabinet according to Logic Module Removal/Replacement procedure in this chapter.
- ___ 18. Set all Vx DISCONNECT, 50/60 Hz DISCONNECT, and MAIN DISCONNECT circuit breakers to ON.
- ___ 19. Set LOC/REM switch to REM.

Heat Sink Temperature Checks

Use this procedure to test the temperature sensors (1TS2 or 1TS3) on the power diode heat sink.

Tools/parts required

- Low-temperature heat gun or hair dryer

Procedure

- ___ 1. Set controls on power distribution box of IOU cabinet being checked as follows:
 - ___ a. LOCL/REM switch to LOC.
 - ___ b. All Vx DISCONNECT, 50/60 Hz DISCONNECT, and MAIN DISCONNECT circuit breakers to ON.

⚠ CAUTION

Do not direct heat gun output on solder connections of temperature sensor.

- ___ 2. Apply heat to temperature sensor with low-temperature heat gun or hair dryer while observing following:
 - ___ a. HEAT SINK HIGH TEMP indicator lights.
 - ___ b. After a maximum of 2 minutes, POWER ON indicator goes out (dc voltage to all buses removed).
 - ___ c. Cabinet blower assembly stops.
- ___ 3. Remove heat to temperature sensor.
- ___ 4. Press and release RESET switch, and observe following:
 - ___ a. HEAT SINK HIGH TEMP indicator goes out.
 - ___ b. POWER ON indicator lights.
 - ___ c. Cabinet blower assembly starts.
- ___ 5. Repeat steps 1 through 4 for other heat sink temperature sensor.
- ___ 6. Set LOC/REM switch to REM.

Backup Thermostat Checks

Use this procedure to test the backup thermostats (1S1 or 1S2) on the power diode heat sink.

Tools/parts required

- Low-temperature heat gun or hair dryer

Procedure

- ___ 1. Set controls on power distribution box of IOU cabinet being checked as follows:
 - ___ a. LOC/REM switch to LOC.
 - ___ b. All Vx DISCONNECT, 50/60 Hz DISCONNECT, and MAIN DISCONNECT circuit breakers to OFF.
- ___ 2. Remove screws securing thermostat to heat sink (refer to Thermostat Removal/Replacement procedure). Pull assembly clear of heat sink, but leave its cable connected.
- ___ 3. Set all Vx DISCONNECT and MAIN DISCONNECT circuit breakers to ON.
- ___ 4. Apply heat to thermostat with low-temperature heat gun or hair dryer while observing following:
 - ___ a. All Vx DISCONNECT, 50/60 Hz DISCONNECT, circuit breakers trip to OFF.
 - ___ b. POWER ON indicator goes out (dc voltage to all buses removed).
 - ___ c. BACKUP indicator lights.
- ___ 5. Remove heat to thermostat, and install it on heat sink.
- ___ 6. Press and release RESET switch, and observe following:
 - ___ a. BACKUP indicator goes out.
 - ___ b. CIRCUIT BREAKER OFF/TRIP indicator lights.
- ___ 7. Set all Vx DISCONNECT circuit breakers to ON.
- ___ 8. Press and release RESET switch, and observe following:
 - ___ a. CIRCUIT BREAKER OFF/TRIP indicator goes out.
 - ___ b. POWER ON indicator lights.
- ___ 9. Repeat steps 1 through 8 for other heat sink thermostat.
- ___ 10. Set LOC/REM switch to REM.

Circuit Breaker Off Sense

This procedure tests the operation of the circuit breaker off sensing circuit.

Procedure

- ___ 1. Apply power to cabinet to be checked.
- ___ 2. On power distribution box for cabinet, set LOC/REM switch to LOC.
- ___ 3. Set any one of the Vx DISCONNECT circuit breakers to OFF and observe following:
 - ___ a. Remaining Vx voltages go to zero and blower stops.
 - ___ b. CIRCUIT BREAKER OFF/TRIP lights.
 - ___ c. POWER ON indicator goes out.
- ___ 4. Set all Vx DISCONNECT circuit breakers to ON.
- ___ 5. Press and release RESET switch, and observe following:
 - ___ a. CIRCUIT BREAKER OFF indicator goes out.
 - ___ b. POWER ON indicator lights.
- ___ 6. Repeat steps 3 through 5 for remaining Vx DISCONNECT circuit breakers.
- ___ 7. Set LOC/REM switch to REM.

Airflow Sense

This procedure checks the operation of a cabinet's blower airflow sensing circuit.

Procedure

- ___ 1. Apply power to cabinet to be checked.
- ___ 2. Set controls on power distribution box of IOU cabinet being checked as follows:
 - ___ a. LOC/REM switch to LOC.
 - ___ b. MAIN DISCONNECT circuit breaker to OFF.
 - ___ c. 50/60 Hz DISCONNECT circuit breaker to OFF.
- ___ 3. Set MAIN DISCONNECT circuit breaker to ON and observe following:
 - ___ a. Blower assembly does not start.
 - ___ b. Within three minutes, BLOWER FAULT indicator on power distribution box lights, and one minute later POWER ON indicator goes out.
- ___ 4. Set MAIN DISCONNECT circuit breaker to OFF.
- ___ 5. Set 50/60 Hz DISCONNECT circuit breaker to ON.
- ___ 6. Set MAIN DISCONNECT circuit breaker to ON.
- ___ 7. Press and release RESET switch, and observe following:
 - ___ a. Blower assembly starts.
 - ___ b. POWER ON indicator lights.
 - ___ c. BLOWER FAULT indicator goes out after one minute.
- ___ 8. Set LOC/REM switch to REM.

Tables 6-1 and 6-2 provide the part number, description, and reference designator (if applicable) for each field replaceable unit (FRU).

Figures 6-1 and 6-2 provide selective location information that, when used in combination with the figures and procedural information in chapter 5, allows accurate identification of the spared FRUs.

Figures 6-3 and 6-4 show the logic cage locations for the spared logic module assemblies.

Table 6-1. AT478-B Input/Output Unit FRUs

Part Number	Description	Reference Designator
00815437	Washable filter	
22133906	Temperature sensor assembly	1TS1 - 1TS4
24564219	Thermostat	1S1, 1S2
37101712	Rectifier, silicon controlled	1CR38, 1CR39
18840102	Diode	1CR1 - 1CR12
18937300	Diode	1CR25 - 1CR36
12117309	Capacitor, 18 000 μ F, 10 V dc	1C1, 1C6, 1C7, 1C12 - 1C20
19266534	Cable assembly, CYBER 170 channel	
19268401	Cable assembly, TPM back panel	
12152300	Transformer, 5.2 V, 750 A	1T3
15182000	Transformer, -3.0 V, 400 A	1T1
53600600	Power distribution box assembly	1A4
15385077	Capacitor, 40 V dc, 12 000 μ F	1A4C1
15005251	Circuit breaker, 400 Hz	1A4CB4
15385076	Capacitor, 6300 μ F	1A4C2
18435600	Voltmeter, DC external multimeter	1A4M1
18556511	Voltmeter multiplier assembly	(part of 1A4M1)
18440703	Circuit breaker, auxiliary switch	1A4CB2
18440720	Circuit breaker, 400 Hz, auxiliary switch	1A4CB1
15005180	Circuit breaker, 50/60 Hz	1A4CB6
18906200	Relay, 4PDT, 25 A	1A4K1, 1A4K2
18906205	Relay, 4PDT, 25 A	1A4K4
22679707	Power warning board	1A4A1
12089201	Relay, 250 mA	1A4A1K6
52948188	Relay, latching	1A4A1K7
23253800	Transformer, variable, 5 kVA	1A4T2
30090600	Transformer, variable, 3 kVA	1A4T1
50242201	Bridge rectifier, 30 A, 100 V	1A4CR1
51683710	Circuit breaker, 1P, 250 V	1A4CB5
52807821	Contact, 40 A, 50-400 Hz,	1A4K3
53973800	Transformer, step down 0.75 kVA	1A4T5
94346400	Transformer, power	1A4T4

(Continued)

Table 6-1. AT478-B Input/Output Unit FRUs *(Continued)*

Part Number	Description	Reference Designator
22786541	Blower assembly	1A1B1
53600650	Sensor assembly, airflow	1A1A1
53600632	Two-port multiplexer power supply	1A7
96744777	Filter, RFI	1A5FL1
15473131	Filter, RFI	1A5FL2
77966910	Power multiplexer board	1A3
96785601	Contact strip, adhesive-back	
19269132	Logic module, 1CQO	
41650006	Logic module, 1JAH	
41650233	Logic module, 1KBH	
41650407	Logic module, 1JCH	
41650603	Logic module, 1JDH	
41650806	Logic module, 1JEH	
41651006	Logic module, 1JFH	
41651208	Logic module, 1JGH	
41651410	Logic module, 1JHH	
41651607	Logic module, 1JJH	
41651809	Logic module, 1JKH	
41652004	Logic module, 1JLH	
41652205	Logic module, 1JMH	
41652804	Logic module, 1JQH	
41653035	Logic module, 1KRH	
41653209	Logic module, 1JSH	
41653406	Logic module, 1JTH	
41653607	Logic module, 1JUH	
41653806	Logic module, 1JVH	
41654009	Logic module, 1JWH	
41655801	Logic module, 1HRH (if AT509-A is installed)	
41653006	Logic module, 1JRH (if AT510-A is installed)	

Table 6-2. AT481-B Input/Output Unit FRUs

Part Number	Description	Reference Designator
00815437	Washable filter	
22133906	Temperature sensor assembly	1TS1 - 1TS4
24564219	Thermostat	1S1, 1S2
37101712	Rectifier, silicon controlled	1CR37 - 1CR39
18840102	Diode	1CR1 - 1CR12
18840300	Diode	1CR13 - 1CR24
18937301	Diode	1CR25 - 1CR36
12117309	Capacitor, 18 000 μ F, 10 V dc	1C1 - 1C20
53577060	Cable assembly, ISI channel	
22132510	Cable assembly, IPI channel	
19266534	Cable assembly, CYBER 170 channel	
22845800	Transformer, 6.6 V, 400 A	1T2
12152300	Transformer, 5.2 V, 750 A	1T3
15182000	Transformer, -3.0 V, 400 A	1T1
53600603	Power distribution box assembly	1A4
15385077	Capacitor, 40 V dc, 12 000 μ F	1A4C1
15005251	Circuit breaker, 400 Hz	1A4CB4
15385076	Capacitor, 6300 μ F	1A4C2
18435600	Voltmeter, DC external multimeter	1A4M1
18556511	Voltmeter multiplier assembly	(part of 1A4M1)
18440703	Circuit breaker, auxiliary switch	1A4CB2, 1A4CB3
18440720	Circuit breaker, 400 Hz, auxiliary switch	1A4CB1
15005180	Circuit breaker, 50/60 Hz	1A4CB6
18906200	Relay, 4PDT, 25 A	1A4K1, 1A4K2
18906205	Relay, 4PDT, 25 A	1A4K4
22679707	Power warning board	1A4A1
12089201	Relay, 250 mA	1A4A1K6
52948188	Relay, latching	1A4A1K7
23253800	Transformer, variable, 5 kVA	1A4T2, 1A4T3
30090600	Transformer, variable, 3 kVA	1A4T1
50242201	Bridge rectifier, 30 A, 100 V	1A4CR1
51683710	Circuit breaker, 1P, 250 V	1A4CB5
52807821	Contactor, 40 A, 50-400 Hz,	1A4K3
53973800	Transformer, stepdown 0.75 kVA	1A4T5
94346400	Transformer, power	1A4T4
22786541	Blower assembly	1A1B1
53600650	Sensor assembly, airflow and cable	1A1A1
96744777	Filter, RFI	1A5FL1
15473131	Filter, RFI	1A5FL2
77966910	Power multiplexer board	1A3
96785601	Contact strip, adhesive-back	
41650006	Logic module, 1JAH	
41650233	Logic module, 1KBH	
41653035	Logic module, 1KRH	
41653209	Logic module, 1JSH	
41653406	Logic module, 1JTH	
41654009	Logic module, 1JWH	
41654404	Logic module, 1JYH	
41654802	Logic module, 1KAH	

(Continued)

Table 6-2. AT481-B Input/Output Unit FRUs *(Continued)*

Part Number	Description	Reference Designator
41654203	Logic module, 1JXH	
41654604	Logic module, 1JZH	
41655401	Logic module, 1LXH	
41655602	Logic module, 1LZH	
41655001	Logic module, 1KXH	
41655203	Logic module, 1KZH	

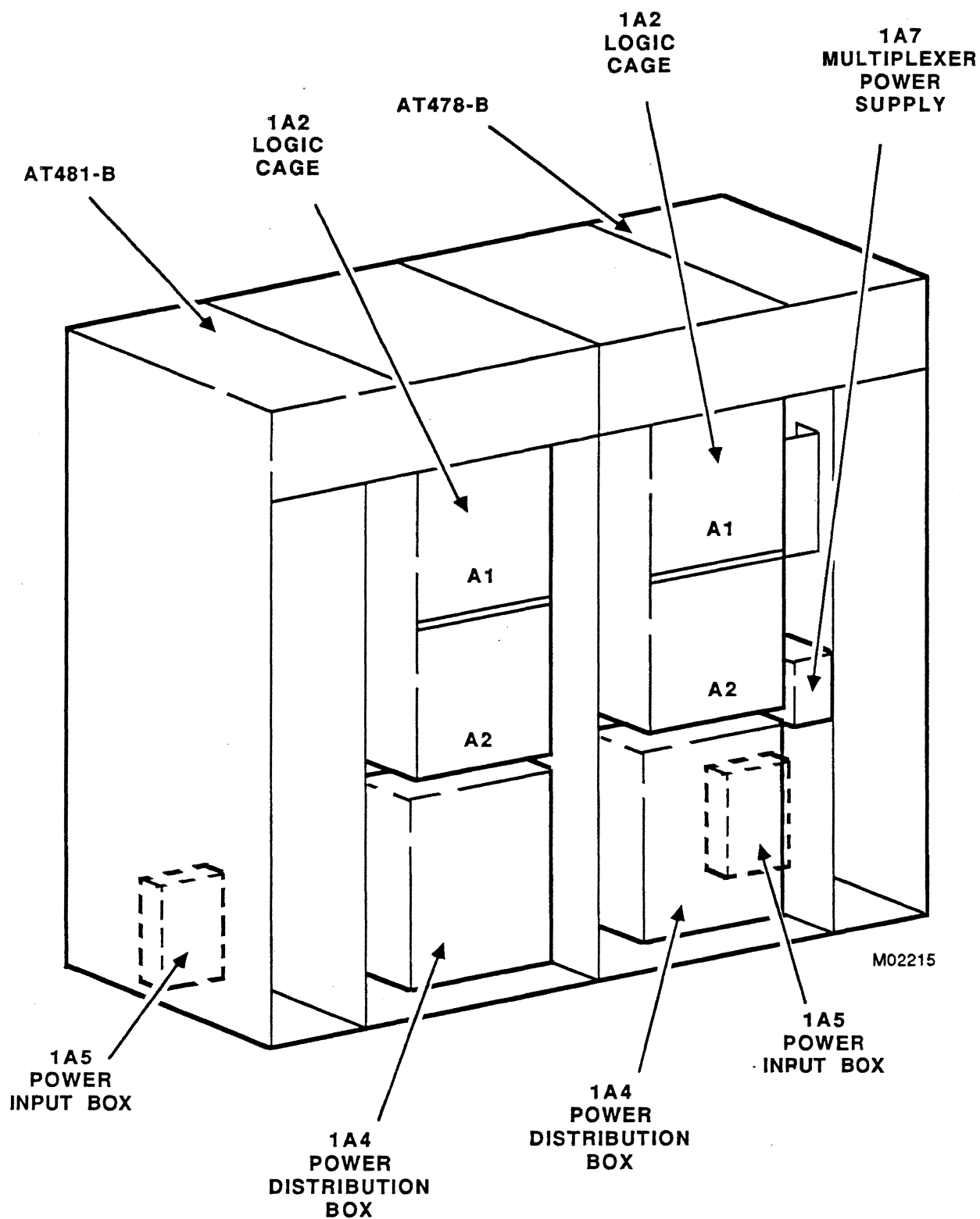


Figure 6-1. Cabinet Front View, Selected Assembly Locator

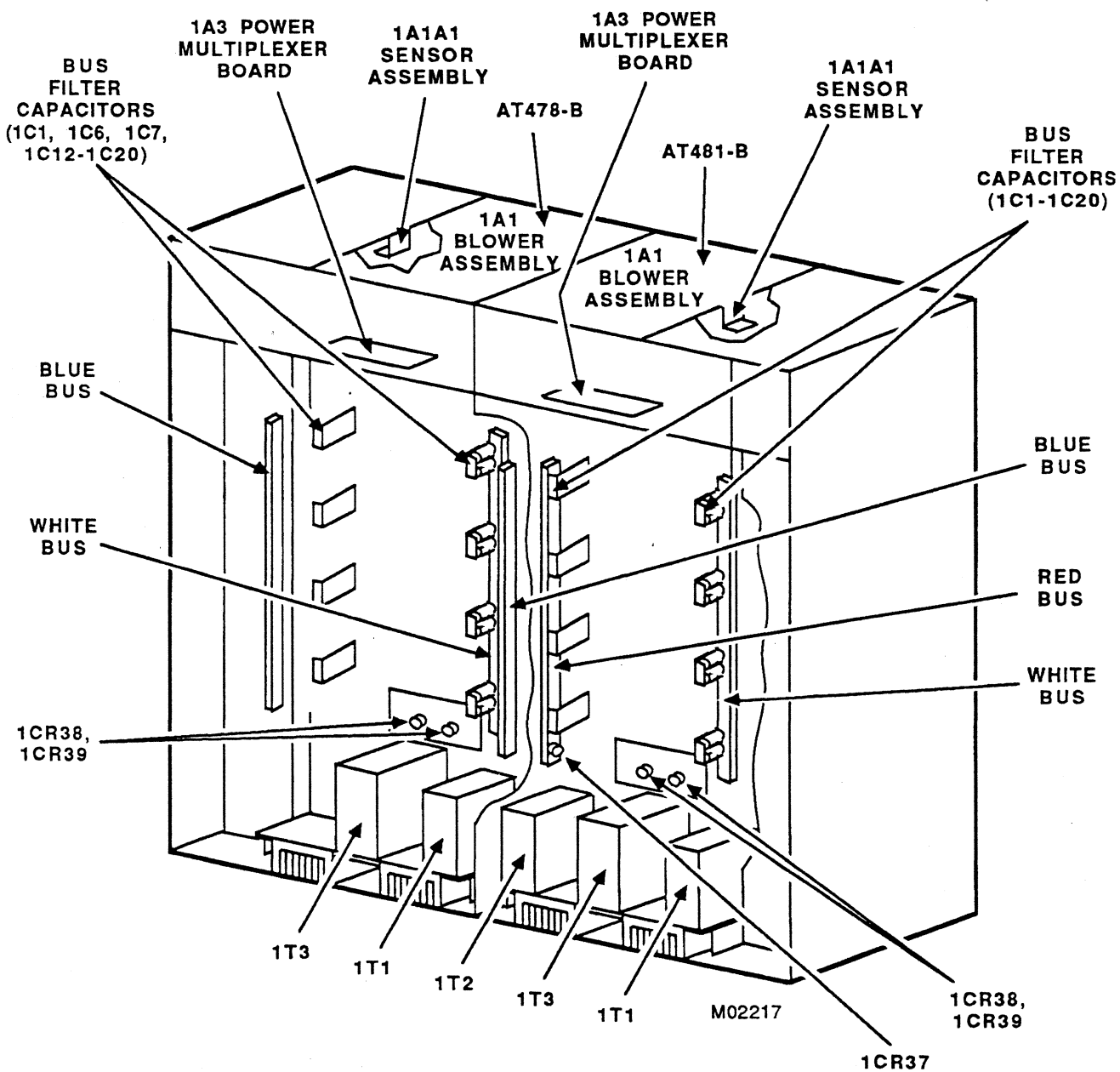


Figure 6-2. Cabinet Rear View, Selected Assembly Locator

1A2A1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1 J A H	1 J H H	1 J H H	1 J H H	1 J H H	1 J J H	1 J J H	1 J G H	1 J U H	1 J U H	1 J C H	1 J V H	1 J V H	1 J E H	1 J D H	1 J F H	1 J F H	1 J F H		1 J S H	1 J T H	1 J Q H	1 - R H					
								△1			△1				△1							△2					
CLK ←					CMI		→	←				ADU							MR	MR	MAC	RI					
																			NU				NU	NU	NU	NU	NU

1A2A2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28		
1 J M H	1 J L H	1 J L H	1 J L H	1 J L H	1 J L H	1 J L H	1 J W H	1 K R H	1 J W H	1 K R H	1 J W H	1 K R H	1 J W H	1 K R H	1 J L H	1 J L H	1 J L H	1 J L H	1 J L H	1 J L H	1 C Q O	1 J K H			1 K B H	1 K B H	1 K B H	1 K B H	
UTC	← NIO CHAN 20-33				→		←		NIO BAS 0-3				→		←		NIO CHAN 0-13				→		D S C	T P M		← NIO PPM		→	
	32 / 33	30 / 31	26 / 27	24 / 25	22 / 23	20 / 21	3	3	2	2	1	1	0	0	0 / 1	2 / 3	4 / 5	6 / 7		12 / 13		10			25 / 31	20 / 24	5 / 11	0 / 4	

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NOTES:

- 1** PROVIDED AS A PART OF AT481-B (IF PRESENT).
- 2** LOGIC MODULE IS 1HRH IF AT509-A IS INSTALLED OR 1JRH IF AT510-A IS INSTALLED.

Figure 6-3. AT478-B Logic Cage Location Assignments

1A2A1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
							1 K A H	*	*	*	*	*	*	*	*	*	*	*	*	*	1 J Y H	*	1 J W H	1 K R H	1 K B H		1 J A H
							△ 2																△ 2	△ 2	△ 2		
								E X T	D M A	B A S																	
								I / F	A D U	I / F																	
NU	NU	NU	NU	NU	NU	NU	NU	5	5	5	6	6	6	7	7	7	10	10	10	11	11	11					NU

1A2A2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
							1 K A H	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	1 J W H	1 K R H	1 K B H	1 J S H	1 J T H	
							←	E X T	D M A	B A S												→	→	CIO BAS 0	→	→	M R	→
								I / F	A D U	I / F																		
NU	NU	NU	NU	NU	NU	NU		0	0	0	1	1	1	2	2	2	3	3	3	4	4	4						

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NOTES:



CHANNEL-TYPE IS SPECIFIED BY CUSTOMER:

AT490-B IS AN ISI/DMA CHANNEL AND USES 1JXH AT LOCATION *, A 1JYH AT LOCATION **, AND A JZH AT LOCATION ***.

AT497-B IS AN IPI/DMA CHANNEL AND USES 1LXH AT LOCATION *, A 1JYH AT LOCATION **, AND A 1LZH AT LOCATION ***.

AT498-B IS A CYBER 170/DMA CHANNEL AND USES A 1KXH AT LOCATION *, A 1JYH AT LOCATION **, AND A 1KZH AT LOCATION ***.



PROVIDED AS PART OF AT482-B.

Figure 6-4. AT481-B Logic Cage Location Assignments

AT511-A/AT512-A General Information

7

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Each of the two cabinet types described in this chapter, functions as a separate subsystem of the IOU system (figure 7-1) of which it is a part. The AT511-A Concurrent Input/Output (CIO) unit can function as an IOU by itself. However, the AT512-A CIO can be used only in the presence of the AT511-A.

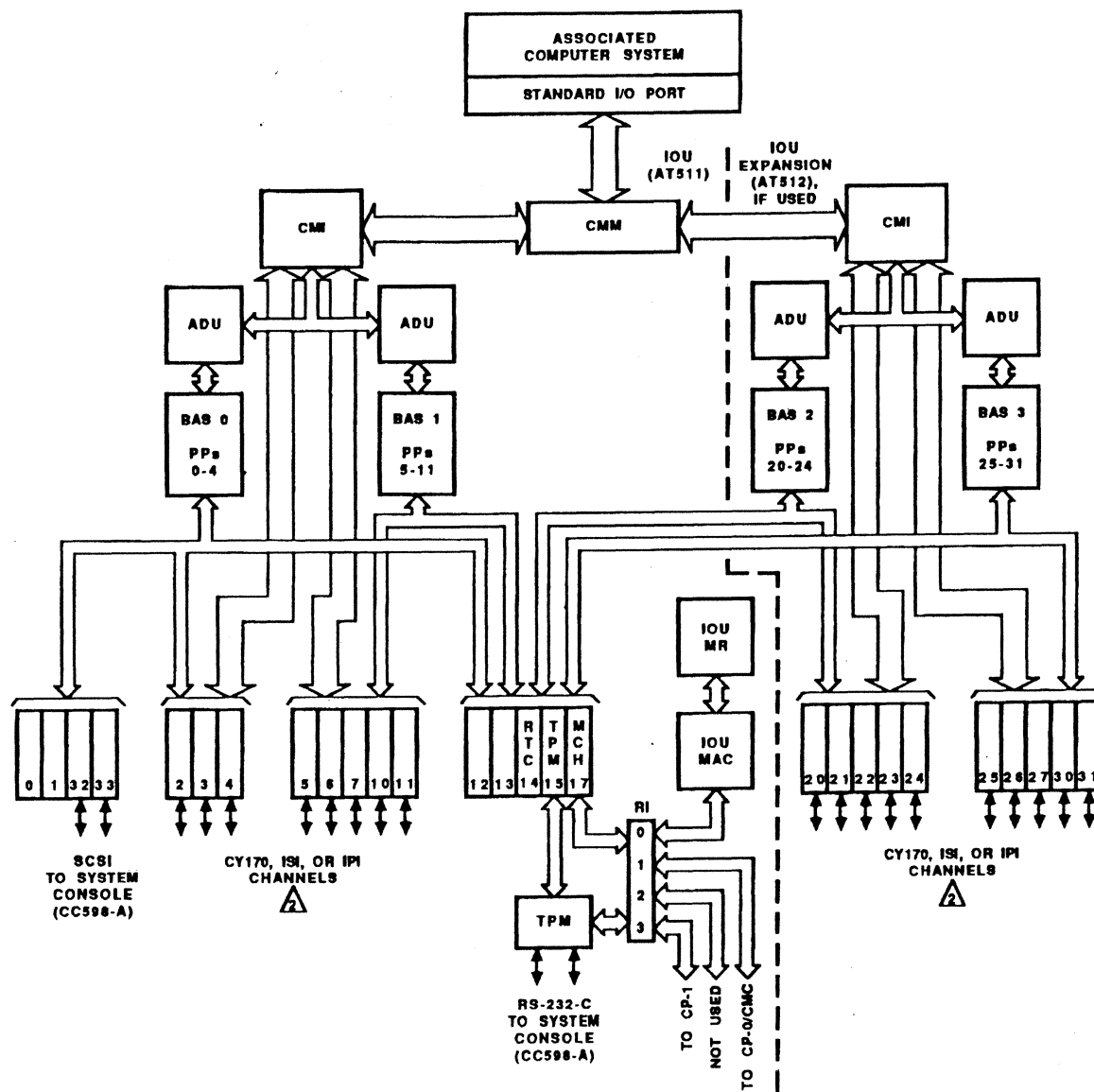
AT511-A CIO

The CIO consists of 10 peripheral processors (PPs). Each PP contains 8192 16-bit words of memory and a repertoire of 114 instructions. Each group of five PPs is organized in a time multiplexing system called a barrel and slot (BAS). The BAS allows PPs to share common hardware for arithmetic, logical, and input/output operations without losing speed or independence. The barrels operate on a major cycle time (one trip) of 250 ns and a minor cycle of 50 nanoseconds. Each barrel has a set of five dedicated direct memory access (DMA) I/O channels. These channels are accessible only by the PPs in that barrel, which eliminates the capability of inter-barrel communications via the I/O channels. In addition to the dedicated channels, all PPs have access to five special function channels.

DMA refers to the capability of moving data between an I/O channel and central memory (CM) without using PP memory as an intermediate buffer. Concurrent DMA is implemented by enhancing the I/O channels in the CIO subsystem with a separate data path to the CM port. In a transfer of this type, the channel controls data flow thus allowing the PP to run concurrently. Channels 2 through 11, octal, support DMA transfers.

AT512-A CIO

The AT512-A consists of either five or 10 PPs (AT513-A adds five additional PPs) that are partitioned into one or two barrels of five PPs. These PPs are identical to those in the AT511-A. Each barrel of the CIO has a set of five DMA I/O channels: channels 20 through 31, octal. These channel groups are dedicated to a barrel; no inter-barrel communications is possible.



NOTES:

1. ABBREVIATIONS:

ADU	ASSEMBLY/DISASSEMBLY UNIT
BAS	BARREL AND SLOT
CM	CENTRAL MEMORY
CMC	CENTRAL MEMORY CONTROL
CMI	CENTRAL MEMORY INTERFACE
CMM	CENTRAL MEMORY MULTIPLEXER
CP-0	CENTRAL PROCESSOR 0
CP-1	CENTRAL PROCESSOR 1
CY170	CYBER 170
I/O	INPUT/OUTPUT
IOU	INPUT/OUTPUT UNIT
IPI	INTELLIGENT PERIPHERAL INTERFACE
ISI	INTELLIGENT STANDARD INTERFACE
MAC	MAINTENANCE ACCESS CONTROL
MCH	MAINTENANCE CHANNEL
MR	MAINTENANCE REGISTER
PP	PERIPHERAL PROCESSOR
RI	RADIAL INTERFACE
RTC	REAL-TIME CLOCK
SCSI	SMALL COMPUTER SYSTEM INTERFACE
TPM	TWO-PORT MULTIPLEXER

2. TYPES OF PERIPHERAL DEVICE CHANNELS THAT CAN BE SELECTED BY CUSTOMER.

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Figure 7-1. AT511-A/AT512-A Input/Output Unit System

Configurations

The IOU system supports the following configuration extremes.

- Minimum configuration of 10 CIO PPs with up to 8 I/O channels.
- Maximum configuration of 20 CIO PPs with 18 I/O channels.

Special channels are allocated for special functions as follows:

1. Channels 0 and 1 are internal channels and do not support any external devices. These channels are accessible only by PPs in barrel 0.
2. Channels 12 and 13, octal, are internal channels dedicated to communications between PPs. Any PP in the IOU system can access these channels.
3. Channel 14, octal, is connected to a real time clock (RTC). This channel is accessible by any PP in the IOU system.
4. Channel 15, octal, is connected to the two-port multiplexer (TPM). This channel provides the serial interface needed to connect directly to a CC598-A system console. This channel is accessible by any PP in the IOU system.
5. Channel 17, octal, is connected to the maintenance channel (MCH) which includes seven radial interfaces. This channel is accessible by any PP in the IOU system.

External Interfaces

The IOU has the following external interfaces.

NOTE

Channel and PP number designators are octal.

CIO Channels

In the CIO subsystem, PPs within a barrel may communicate with any other PP in the same barrel either on that barrel's dedicated I/O channels or on the common channels (12, 13, 15, 17). Communications between barrels must be done via channels 15 or 17. Communications between PPs is always on a 16-bit boundary. Channels 2 through 4, 5 through 11, 20 through 24, and 25 through 31 are all DMA enhanced adapters. These channels support CYBER 170/DMA channels, intelligent standard interface (ISI)/DMA channels, and intelligent peripheral interface (IPI)/DMA channels.

The CYBER 170/DMA channel adapter provides an interface between the IOU and a CYBER 170 channel. This adapter supports two different transfer rates. They are a 3M bytes/s handshake (standard CYBER 170), and a 15M bytes/s burst (fast transfer mode). This adapter has three interfaces: a 12-bit plus parity bit for external interfaces, a 16-bit plus parity bit for the I/O channel bus, and a 64-bit plus eight parity bits for the DMA bus. The adapter contains control and status registers, assembly/disassembly registers, CM address and word count registers, and function decode logic.

The ISI/DMA channel adapter provides an interface between the IOU and an ISI. The maximum I/O transfer rate that can be achieved on this adapter is 12M bytes/s. This adapter has four interfaces: two 16-bit plus two parity bits for external interfaces, a 16-bit plus parity bit for the I/O channel bus, and a 64-bit plus eight parity bits for the DMA bus. The adapter contains control and status registers, assembly/disassembly registers, CM address and word count registers, and function code logic.

The IPI/DMA channel adapter provides an interface between the IOU and an IPI. The maximum I/O transfer rate that can be achieved on this adapter is 10M bytes/s. This adapter has four interfaces: two 16-bit plus two parity bits for external interfaces, a 16-bit plus parity bit for the I/O channel bus, and a 64-bit plus eight parity bits for the DMA bus. The adapter contains control and status registers, assembly/disassembly registers, CM address and word count registers, and function code logic.

Clocks

The CM or CMC of the associated computer system sends clocks to the IOU that are dependent on the computer system (refer to IOU Interfaces in chapter 1).

These clocks are connected to the IOU by two separate signal lines. The clocks are received on the master clock logic module (1HAH) and are distributed to the CM interface logic.

Maintenance Channel (MCH)

The maintenance channel is the interface between the IOU's maintenance registers and the associated computer system's processors, memories, and so forth. The IOU uses this channel to initialize the processor and memories. The IOU controls the operating environment and monitors the operating conditions of each of the computer system elements connected to the MCH. All I/O instructions can be executed on the MCH, and channel 17 is dedicated to the MCH.

The radial interface (RI) allows the maintenance access controllers of up to three mainframe elements to connect to the MCH. The RI is designed so that any connected element can be disconnected or shutdown without affecting the other elements.

Two-Port Multiplexer (TPM)

The TPM, located on the 1JKH logic module, is an asynchronous communications interface connected to channel 15. It contains two RS-232-C ports (port 0 and port 1) that can be used with the channel one at a time. Each port contains a 64-character buffer for receiving data from channel 15, and a three-character buffer for receiving data from the port to be sent to the channel.

The TPM supports a CC598-A system console. Ports 0 and 1 are both connected to the CC598-A. The system console is the principal device by which the operator interacts with the system. The TPM and the system console combine to deadstart the mainframe and/or the IOU and to perform utility functions for the various software systems: OS, CTI, CMSE, and so forth. The console is used to initiate the deadstart with a sequence that causes the TPM to recognize the system console as a legal deadstart device and to also allow an information exchange relative to any secondary IOU in the configuration. Once the system is running, the TPM acts as a pass-through device. The TPM and console communicate in a packet protocol when performing their utility functions for software.

Central Memory Multiplexer (CMM)/Central Memory Interface (CMI)

Each PP can read and write data to CM. The PP can read/write data from/to either a 60-bit CM word or a 64-bit CM word. Both modes are dynamically supported and mixed-mode is permitted. A 60-bit CM word is assembled/disassembled into four 16-bit PP words. Each of these words is written or read from successive locations in PP memory. Each DMA enhanced I/O channel can read and write data to CM. The ISI and IPI channels support only 64-bit CM words.

A 64-bit CM word is assembled/disassembled into four successive 16-bit channel words. The CYBER 170 channel supports both 60- and 64-bit CM words. In 60-bit mode, the channel uses five 12-bit channel words to form a 60-bit word. In 64-bit mode, sixteen 12-bit channel words are used to form three 64-bit CM words. Data, addresses, and control are resynchronized to and from the CM clock in the CMI.

The CMM/CMI connects to a standard port on the associated computer system. This interface runs on a CM clock which is asynchronous to the IOU. The CMI logic in the IOU provides the resynchronization. This interface supports a bandwidth of up to one 64-bit word every 56 ns (142M bytes/s).

Performance Monitoring

There are no special facilities in the IOU to monitor or record activity for the express purpose of performance monitoring. All performance monitoring is done with the aid of external hardware. The IOU provides test points on signals of interest for the purpose of performance monitoring.

IOU Components

The following paragraphs describe the major components of the IOU.

Central Memory Multiplexer (CMM)

The CMM contains the transmitters and receivers used to interface with the central memory control. In addition to the transmitters and receivers, the CMM multiplexes the requests from the two CMIs.

Central Memory Interface (CMI)

The CMI controls all CM requests. The three inputs to the CMI are from the two ADUs, DMA channels 0 through 4, and DMA channels 5 through 11. The data transfer to and from the CMI is 64-bit data words with eight parity bits. (This configuration is the same in an AT512-A cabinet, except the DMA channels are numbered 20 through 31, octal.)

The CMI also handles the resynchronization of all data and control signals between the internal 50-ns clock system and the external 64-ns clock system.

The CMI can hold up to eight requests for the ADU bus and up to 16 requests from each DMA channel bus. The CMI can accept simultaneous requests from all three units every internal clock cycle. It is the requesting unit's responsibility to regulate the number of requests out to the CMI. The CMI is capable of sending a request to CM every external clock cycle.

The CMI handles all requests in the same manner whether it is a read request or a write request. Whenever the CMI receives a valid request, the corresponding output buffer is written with whatever information is on the bus lines. This information is then sent to the CM when the request is honored. Whenever the CMI receives a valid response, the corresponding input buffer is written with whatever information is on line from the CM. This information is then sent to the requesting unit at the appropriate time, except during a DMA channel write operation when this information from CM is not gated to the DMA channel bus.

PP Memories (PPM)

Each peripheral processor has 8192 words (22 bits/word of which 16 are data bits and 6 are SECDED bits) of memory. At deadstart the memories are degraded to 4096 words. The remaining 4096 words can be enabled by setting bit 32 of the environmental control register. This bit enables 8192 words of memory for each PP in the IOU system. There is no capability to select individual PP memory sizes. Memories are organized into a three-bank system that allows data to be rewritten and corrected during a read. Memory addresses are 16 bits in length and only 13 bits are used. All memories are 16K by 1 bit read/write RAMs. Bank 0 contains the memories for PPs 0 and 3, bank 1 is the memory for PPs 1 and 4, and bank 2 is the memory for PP 2.

Control

Instruction decode and execution control is provided by firmware stored in PROMs. The I-barrel holds the PROM address for the next micrand. The I-barrel has 9 bits of data and 1 parity bit.

Assembly/Disassembly Unit (ADU)

The ADU is used during a write operation to assemble 12/16-bit PP memory words into a 60/64-bit CM word, and during a read operation to disassemble a 60/64-bit CM word into 12/16-bit PP memory words.

The ADU consists of up to four barrels (two barrels maximum per cabinet), each barrel has its own assembly register and disassembly register and handles data from five PPs.

Data is transferred between the ADU and the barrel and slot via 16 data lines and one parity line per barrel. Data is bused between the ADU and the CMI via 64 data lines and 8 parity lines per barrel.

Maintenance Access Control (MAC)

The MAC provides access to the various IOU maintenance registers for the PPs and TPM microprocessor. The MAC is essentially an intelligent, multiple-way data multiplexer under nanocode control. In addition to providing access to the IOU maintenance registers, the MAC also translates functions from the PPs or the TPM microprocessor to perform ADU/CMI Master Clear, IOU Clear Errors, and Clear LEDs.

Maintenance Registers (MR)

The 30 maintenance registers provide the means of indicating fault status in the IOU and environs. The fault status indications for the IOU are done by associating failures with a particular logic module rather than a logical unit. Features to test the fault sensing hardware are provided. Other tools are provided to assist diagnostic and operating system software in IOU identification, fault detection, and error recovery.

CIO Channels

The CIO subsystem contains a maximum of 18 channel locations. Each channel location is three logic module locations wide, and is wired to an I/O channel bus and a DMA bus. The I/O channel bus is used to communicate between the channel and a PP. The DMA bus is used to communicate between the channel and CM. Each channel location can house one of three types of channel adapters. The three types are the CYBER 170/DMA channel adapter, the ISI/DMA channel adapter, and the IPI/DMA channel adapter.

Two-Port Multiplexer (TPM)

The TPM supports data communication using ASCII code. Special features supported by TPM when operating with a CC598-A system console in either single or dual IOU mode include:

- Calendar clock
- Retrievable copies of pre-deadstart P, K, Q, and A registers
- Retrievable copies of pre-deadstart channel status
- Retrievable copies of pre-deadstart environmental control registers
- Retrievable copies of pre-deadstart fault status mask registers
- Alternate IOU configuration information
- Alternate IOU environment control registers
- Alternate IOU options installed registers

Real Time Clock (RTC)

The RTC is 12 bits wide, and is a free-running counter that is incremented every μ s. The RTC is read through channel 14 and is accessible by any PP. Channel 14 is always active and full.

Cabinet Cooling

An IOU cabinet is air cooled by the cabinet elements shown in figure 7-2. Air to cool power supply components is drawn into the rear of the cabinet and into the two ends of the U-shaped heat sink assembly. The heat sink assembly and the heat sink weldment are the major points of heat dissipation from the cabinet power supply components mounted on these sinks. From the heat sink assembly, the air enters the heat sink weldment and the vertical heat duct. Upon leaving the vertical heat duct, the air enters the portion of the cabinet blower chamber containing the blower assembly. The air is then blown into the baffled portion of the cabinet blower chamber, and is exhausted vertically through the grillwork in the top of the chamber.

Air to cool logic modules in the logic cage is drawn into the front of the cabinet, through the filter (washable) in the bottom of the logic cage, and upward between the logic modules into the portion of the cabinet blower chamber containing the blower assembly. The air is then blown into the baffled portion of the cabinet blower chamber, and is exhausted vertically through the grillwork in the top of the chamber.

Cooling is monitored by the following thermostats and temperature sensors.

- Temperature sensors 1TS1, 1TS2, and 1TS3 on the heat sink assembly.
- Thermostats 1S1 and 1S2 on the heat sink assembly.
- Temperature sensor 1TS4 below the bottom right-hand corner of the logic cage.
- Temperature sensor 1A1A1A1 and thermostat 1A1A1A2 in the blower assembly chamber sensing the output of the blower.

These devices monitor and initiate activity as shown in table 7-1.

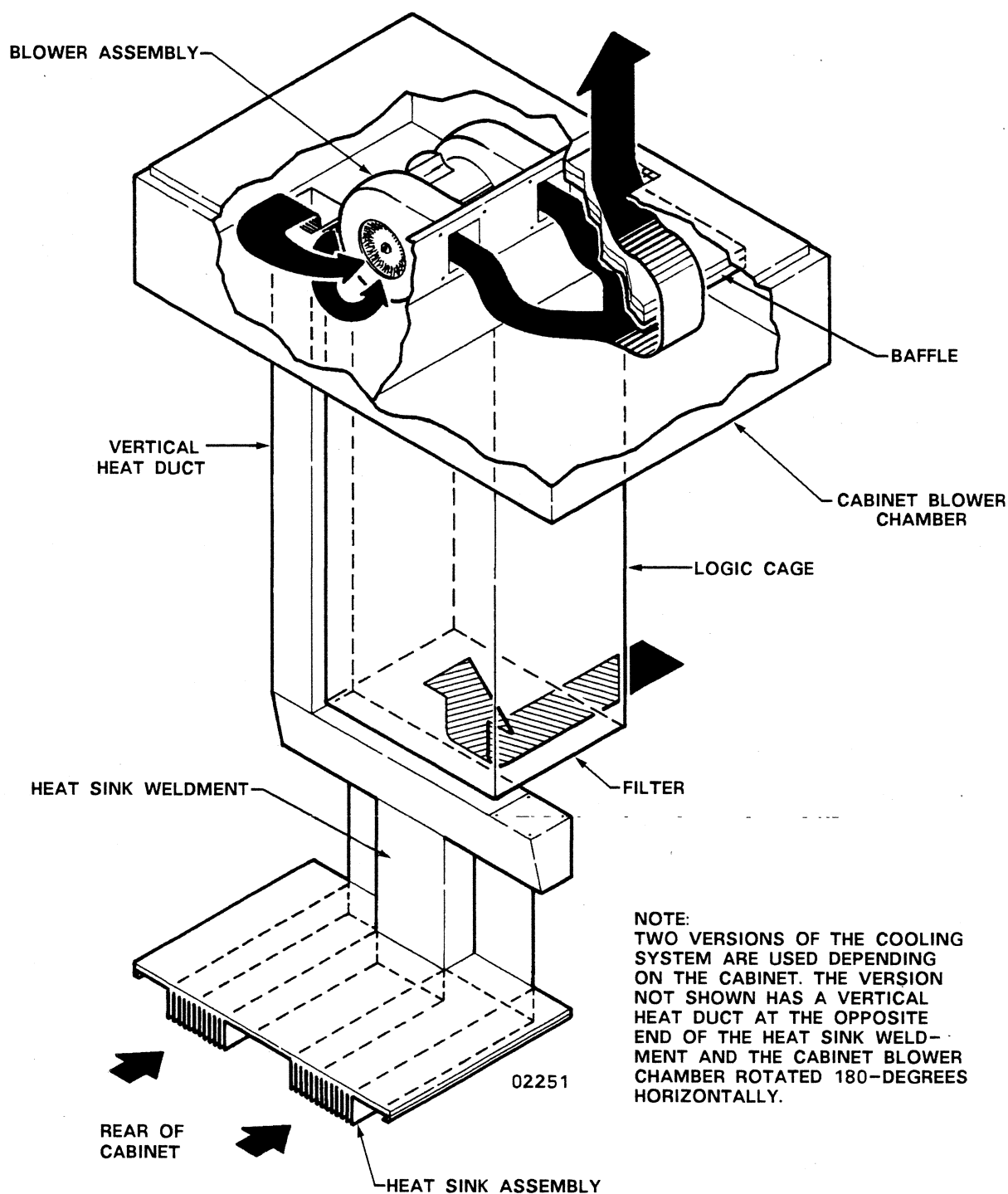


Figure 7-2. IOU Cabinet Air Cooling

Table 7-1. Cabinet Cooling Monitoring Devices

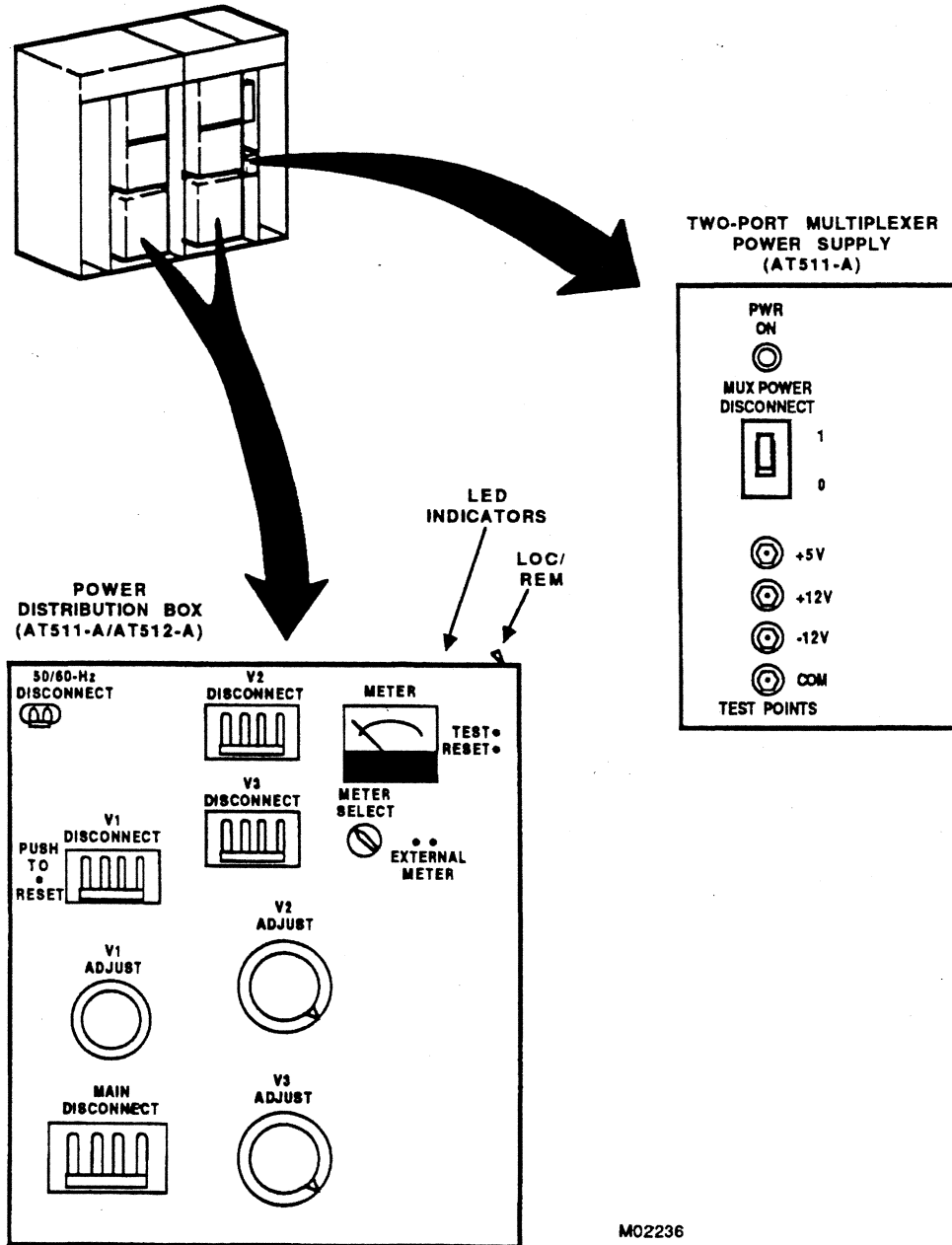
Device	Function	Signal Sent To¹	Action Initiated
1TS1 Temperature Sensor	Provides heat sink temperature, in degrees Fahrenheit.	1A4A1	None.
1TS2 Temperature Sensor	Provides temperature protection for V1 and V2 power diodes on heat sink	1A4A1	Lights HEAT SINK HIGH TEMP LED at a heat sink temperature of 82°C (180°F), signals computer, and after 1 minute removes power to IOU cabinet. Initiates Long Warning.
1TS3 Temperature Sensor	Provides temperature protection for V2 and V3 power diodes on heat sink	1A4A1	Lights HEAT SINK HIGH TEMP LED at a heat sink temperature of 82°C (180°F), signals computer, and after 1 minute removes power to IOU cabinet. Initiates Long Warning.
1TS4 Temperature Sensor	Provides logic cage input air temperature, in degrees Fahrenheit.	1A4A1	None.
1S1 Thermostat	Provides a backup signal for 1TS2	1A4A1	Lights BACKUP LED at a heat sink temperature of 82°C (180°F) and immediately removes IOU cabinet power.
1S2 Thermostat	Provides a backup signal for 1TS3	1A4A1	Lights BACKUP LED at a heat sink temperature of 82°C (180°F) and immediately removes IOU cabinet power.
1A1A1A1 Temperature Sensor	Provides blower assembly output air temperature, in degrees Fahrenheit.	1A4A1	None.
1A1A1A2 Thermostat	Provides temperature protection for IOU power system and logic modules	1A4A1	Lights BLOWER FAULT LED when blower exhaust reaches 65.6°C (150°F), signals computer, and after 1 minute removes power to IOU cabinet. Initiates Long Warning.

Note:

1. 1A4A1 is power warning board in power distribution box.

Controls and Indicators

Figure 7-3 illustrates the controls and indicators on the input/output unit cabinets. In addition to the panel controls and indicators, the majority of the logic modules each contain a light emitting diode (LED). These LEDs and each of the panels shown in figure 7-3 are described in a following paragraph.



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Figure 7-3. IOU Controls and Indicators

Logic Module LEDs

Approximately 80 percent of the IOU logic modules have an LED on their outer edge that when lighted is easily visible through the transparent strips in the logic cage front covers. An LED lights when that logic module detects an error. The LED remains lit until a Clear LED function is performed in the IOU's MAC. Any of the following conditions in an AT511-A or an AT512-A will light an LED.

- Conversion error
- Operating system bounds parity error
- Firmware error
- Register barrel data parity error
- Response code parity error
- Uncorrected read response
- Uncorrected write response
- PP memory read double SECDED error
- PP memory address parity error
- PP memory write parity error
- Y-multiplexer input data parity error
- CM reject
- CM data in error
- CM data out error
- Address function out error

Any of the following conditions in an IOU containing CY170/DMA or ISI/DMA channels will light an LED.

- Uncorrected CM error
- Invalid CM response
- CMI read data parity error
- Test mode error/clock fault
- Overflow error
- Input error
- Timeout/12 - 16 conversion error
- JY (1JYH logic module) data error
- BAS parity error

Any of the following conditions in an IOU containing IPI/DMA channels will light an LED.

- Illegal function
- Uncorrected CM error
- CM reject
- Invalid CM response
- CM response code parity error
- CMI read data parity error
- DMA register parity error
- MAC status parity error
- Timeout
- JY (1JYH logic module) data error
- BAS parity error
- Buffer counter parity error
- Sync counter parity error
- Period counter parity error
- Function upper parity error
- Function lower parity error
- Lost data

- Upper data parity error
- Lower data parity error
- IPI sequence error
- Bus A parity error
- Bus B parity error
- Illegal operation

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Power Distribution Panel

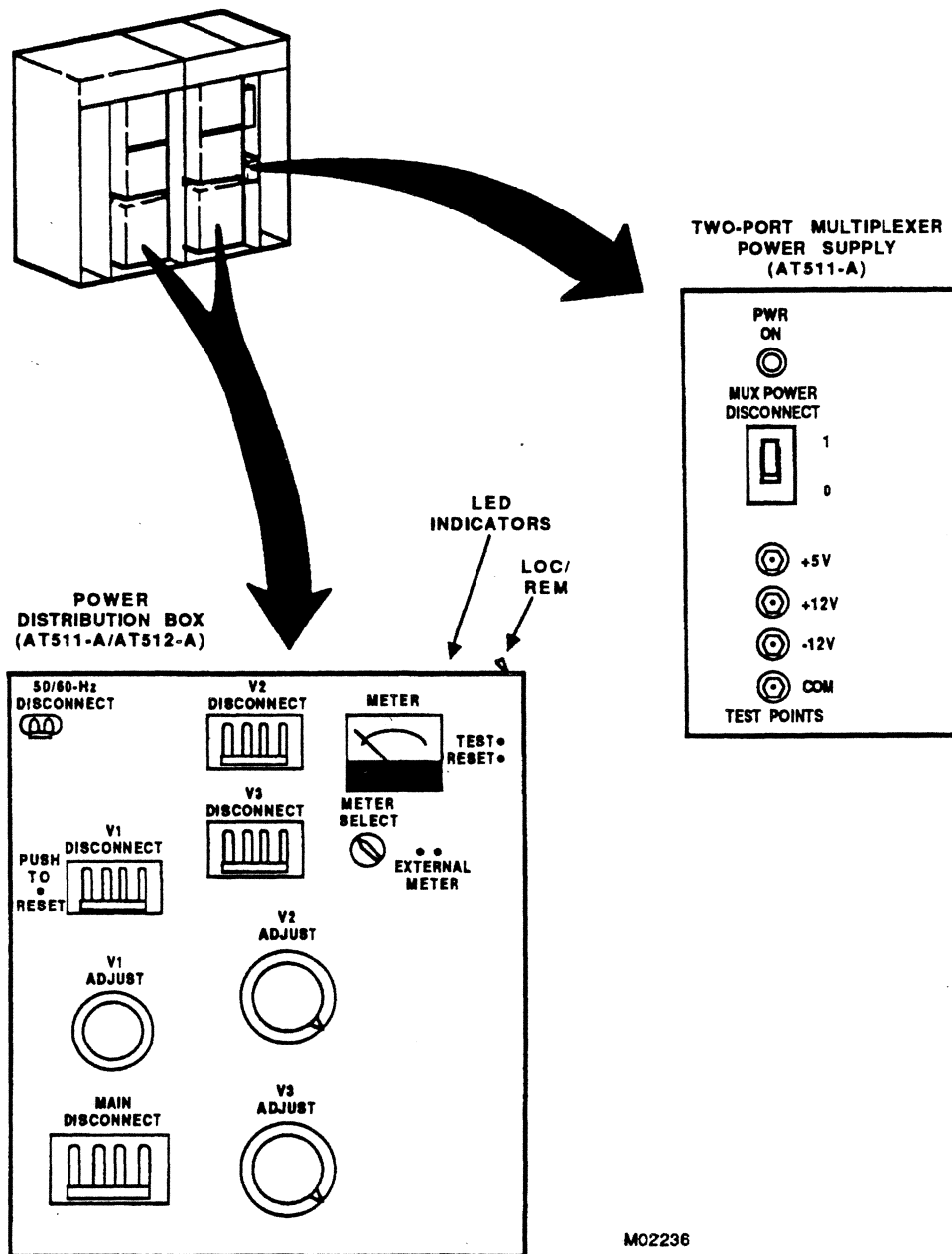
Tables 7-2 and 7-3 describe the function of the controls and indicators on the IOU power distribution panel.

Table 7-2. Power Distribution Box Switches and Circuit Breakers

Device	Panel Nomenclature	Function
Switches		
A4A1S1	LOC/REM	LOC – Specifies that cabinet power-up operation is independent of system; except for LONG WARNING. REM – Specifies that cabinet requires a signal from a remote source in order to power up.
A4A1S2	RESET	Clears all latched faults in power control board.
A4A1S3	TEST	Simulates transient fault condition that trips Vx ¹ DISCONNECT breakers, lights Vx ¹ FAULT indicators, and warns system.
A4S1	METER SELECT	Connects meter, M1, to V1, V2, or V3 bus.
Circuit Breakers		
A4CB1	V1 DISCONNECT	Controls application of 400-Hz, 3-phase power to power transformer 1T1.
A4CB2	V2 DISCONNECT	Controls application of 400-Hz, 3-phase power to power transformer 1T2.
A4CB3	V3 DISCONNECT	Controls application of 400-Hz, 3-phase power to power transformer 1T3.
A4CB4	MAIN DISCONNECT	Controls application of 400-Hz, 3-phase power within power distribution box and (on AT511-A) to TPM power supply.
A4CB5	PUSH TO RESET	Provides cabinet reset capability for 400-Hz, 1-phase voltage to relays A4K3 and A4K4, and transformer A4T4 in power distribution box.
A4CB6	50/60 Hz DISCONNECT	Controls application of either 50-Hz or 60-Hz, 1-phase voltage to transformer A4T5.

Note:

1. V1 is -2.2 V dc, V2 is -5.2 V dc, and V3 is +5.0 V dc (see NOMINAL VOLTAGE label on panel).



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Figure 7-4. IOU Controls and Indicators

Table 7-3. Power Distribution Box Test Points, Autotransformers, and Indicators

Device	Panel Nomenclature	Function
Test Points		
A4TP1, A4TP2	EXTERNAL METER	Power distribution box front panel measurement points for bus voltage currently selected by METER SELECT switch.
Autotransformers		
A4T1	V1 ADJUST	Adjusts level of 400-Hz, 3-phase voltage applied to power transformer 1T1.
A4T2	V2 ADJUST	Adjusts level of 400-Hz, 3-phase voltage applied to power transformer 1T3.
A4T3	V3 ADJUST	Adjusts level of 400-Hz, 3-phase voltage applied to power transformer 1T2.
Indicators		
LED1	BLOWER FAULT	Monitors air-flow sensor output in 1A1 blower assembly. Lights if blower stops.
LED2	BACKUP	Indicates that thermostat 1S1 or 1S2 has sensed an out-of-tolerance temperature at power heat sink.
LED3	CIRCUIT BREAKER OFF/TRIP	Lights to indicate that circuit breaker A4CB1, A4CB2, or A4CB3 is off.
LED4	HEAT SINK HIGH TEMP	Indicates that temperature sensor 1TS2 or 1TS3 has sensed an out-of-tolerance temperature at power heat sink.
LED5	V3 FAULT	Lights if V3 bus voltage is out of tolerance.
LED6	V1 FAULT	Lights if V1 bus voltage is out of tolerance.
LED7	V2 FAULT	Lights if V2 bus voltage is out of tolerance.
LED8	POWER ON	Lights when relay A4K3 activated.

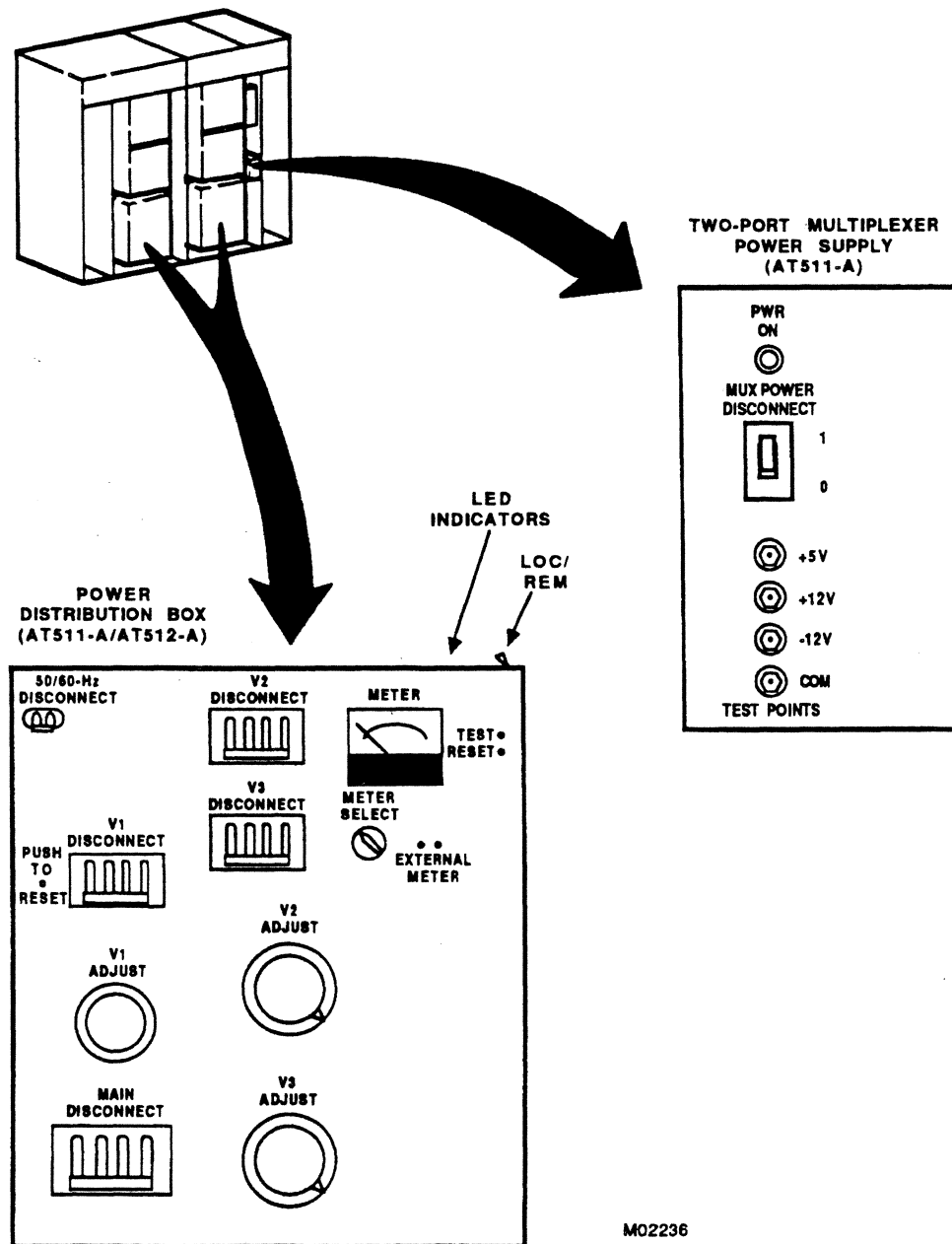


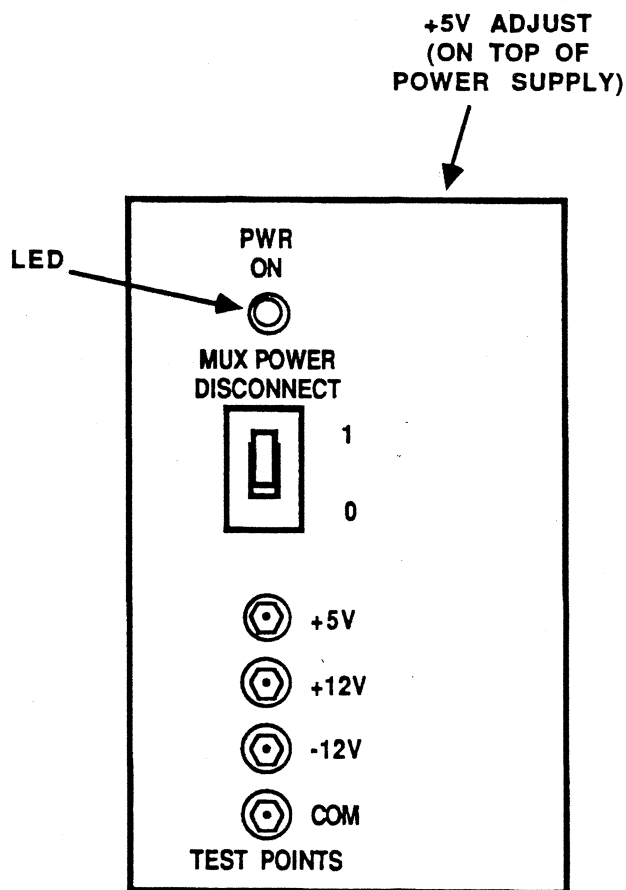
Figure 7-5. IOU Controls and Indicators

Two-Port Multiplexer Power Supply

Figure 7-6 shows and table 7-4 describes the control and indicator functions on the two-port multiplexer power supply on an AT511-A; not on an AT512-A.

Table 7-4. Two-Port Multiplexer Power Supply Controls and Indicators

Panel Nomenclature	Function
PWR ON indicator	Indicates that MUX POWER DISCONNECT circuit breaker is set to ON, 1.
MUX POWER DISCONNECT circuit breaker	Controls application of 400-Hz, single phase, power to TPM power supply.
+5V, +12V, -12V, and COM test points	Allows monitoring of TPM power supply output voltages with external multimeter.



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Figure 7-6. Two-Port Multiplexer Power Supply Indicators and Controls

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Initialization

Initialization of the IOU subsystem precedes all other system initialization. It includes both the actions taken when the IOU is powered up as well as the action taken when the PPs are deadstarted. On completion of its own initialization, the IOU uses the system storage device to provide initialization programs and data for other system elements.

Deadstart Commands and Displays

The TPM has an internal command language consisting of deadstart and maintenance commands. These commands are entered at the system console, and enable the various initialization and deadstart displays on the console's screen. These commands and displays may be used for troubleshooting hardware failures or for diagnosing problems with system software. To these ends, they allow inspection of internal PP data and control information. In addition, they provide a means of establishing hardware scope loops to be run while viewing a hardware fault condition on an oscilloscope.

NOTE

Certain elements of the TPM command language can have a disruptive affect if used while the operating system is running. Use the commands and displays as instructed by the referenced manuals.

To execute the TPM commands, the user must first acquire the TPM Maintenance Options Display for the primary IOU (refer to the 19003 System Console Hardware Operation/Maintenance Guide). The TPM commands are described in either the associated support engineering manual or the standardized maintenance approach quick reference (SMAQR) manual. Displays are described in the system console hardware operation/maintenance guide.

A microprocessor on the TPM logic module, 1JKH, is used to initialize the IOU hardware. The microprocessor displays the deadstart program on the screen of the system console. It will also allow the operator to make changes to the contents of the deadstart program and to look at PP memory, IOU maintenance registers, IOU working registers (P, A, Q, and K), and channel status.

The microprocessor also, when directed, performs the following tasks.

- Executes a short deadstart sequence
- Executes a long deadstart sequence
- Initializes and controls the TPM hardware

Power On Initialization

At power on time, the IOU is initialized to the following state.

- The R register is set to zero for all PPs.
- A 1- μ s Master Clear is issued to all channels and all PPs.
- The first logical PP in the deadstart barrel is forced to idle.
- The 20 MHz clock frequency is set to normal.
- All PP memories are cleared and set to 4K state.
- The OS Bounds registers are cleared.
- The Fault Status registers and logic module error LEDs are cleared.
- Various bits in Environmental Control registers are cleared and set.

Deadstarting Single IOU Configurations

Deadstarting the PPs in a single IOU configuration consists of:

- Activating the deadstart display
- Selecting a short deadstart program
- Executing either a long or a short deadstart sequence

Deadstarting Dual IOU Configurations

Deadstarting the PPs in a dual IOU configuration consists of:

- Activating the deadstart display
- Selecting a short deadstart program
- Executing either a long or a short deadstart sequence

The job of coordinating the actions taken in the different IOUs is assumed by the system console. In a dual IOU PP deadstart, initialization of the IOU system occurs in two phases. In the first phase, the system console puts the secondary IOU into an inactive state by causing a μ s Master Clear to be issued and the first logical PP in the deadstart barrel to be idled. Once this occurs, the system console proceeds with either the long or the short deadstart, as specified by the operator, in the primary IOU. The second phase begins as soon as the short deadstart sequence in the primary IOU is completed. During this phase, the software running in the primary IOU PPs uses the TPM in the primary IOU and the system console to load and execute software in the secondary IOU.

Short Deadstart Sequence

The entry of an S command (followed by carriage return) initiates a short deadstart sequence. In this sequence, a Deadstart Master Clear is issued to the PPs and channels, and the program currently displayed on the system console screen is loaded into logical PP 0. Execution begins at word 1 of this program. At the end of the sequence, the screen of the system console is blanked in preparation for use by the software being deadstarted in PP 0. The program used is the one displayed on the system console screen, and does not necessarily have to be the same as one of the stored programs. Refer to Deadstart Programs.

Long Deadstart Sequence

The entry of an L command (followed by carriage return) initiates a long deadstart sequence. The following events occur in this sequence.

1. A Deadstart Master Clear is issued to the PPs and channels, and error status bits are cleared.
2. The long deadstart program, stored in the TPM program memory, is loaded into logical PP 0 and executed.
3. The PP register display is brought up on the right-hand side of the system console screen while the long deadstart program runs; about 15 seconds.
4. Certain error status bits are monitored to determine if the hardware fails during the long deadstart; failures are indicated via message below PP register display. On successful completion of the program, a short deadstart sequence, as describe previously, is automatically initiated using the program currently displayed on the screen.

Deadstart Programs

The short deadstart sequence causes the 16-word program currently displayed on the system console to be loaded into locations 1 through 20, octal, of PP 0. Execution of the program begins at location 1 as soon as loading is complete. Commands are provided to enter or modify this program. Multiple programs may be created for different uses and may be saved in a special memory. Up to four such programs may be stored using the command entry:

SP x (where x is the program number 0 through 3)

Once the program is stored, it can be retrieved and displayed on the system console at some later time using the command entry:

GP x (where x is the program number 0 through 3)

In addition to the four programs just discussed, there are four more fixed or permanent programs which are numbered 4 through 7. These four programs can be retrieved and displayed on the system console using the command entry:

GP x (where x is the program number 4 through 7)

When a program is retrieved with the GP command, a copy of the program is displayed. If any editing of the program is done, only the copy on the screen is changed. The original version in memory is not modified; stored programs are changed only by an SP x command. Remember though, that it is possible to retrieve a program from one location, modify it, and store it at another location.

Deadstart programs can be inspected, one after the other, by pressing the space bar. Program 0 is displayed after program 7.

Permanent Deadstart Programs 4 Through 7

Four special purpose programs are permanently stored in the TPM microcomputer memory for use by maintenance personnel.

The programs are accessed with the GP x (where x is the program number, 4 through 7) command. The use and description of the programs is as follows.

- Program 4 Clear errors and clear ADU. This test issues the Master Clear and Clear Error functions to the IOU, memory, and associated mainframe.
- Program 5 This test performs data echo tests on channels 0 and 1.
- Program 6 This test performs data echo tests on channels 12 and 13.
- Program 7 This test performs data echo tests on channels 15 and 17.

IOU Reconfiguration

In order to deadstart the NOS/VE operating system, it is necessary that the first, second, and third logical PPs in barrel 0 be functional. If they are all functional, the system may be deadstarted and any failing PPs, other than those mentioned, can be logically turned off using commands described under the Operator Intervention Display in the Disk Deadstart section of the CIP Reference Manual. If, however, one of these PPs is not functional, the IOU hardware configuration procedure should be used as described in the following paragraph to select a set of logical PPs from the available physical PPs such that the first, second, and third logical PPs in barrel 0 are functional.

Hardware reconfiguration of PPs is accomplished by reconfiguring PP memories; AT511-A/AT512-A does not support barrel reconfiguration. PP memories in each barrel can be reconfigured using the deadstart display and command entry:

RP x (where x is the number, 0 through 4, of the physical PP memory that is to be used as logical PP memory 0.)

NOTE

The x-entry in the RP command not only designates which PP in logical barrel 0 is to be PP 0, but also which PP in logical barrel 1 is to be PP 5, which PP in logical barrel 2 is to be PP 20, and which PP in logical barrel 3 is to be PP25.

The reconfiguration specified by the RP command does not take effect until after the next Master Clear.

TPM Battery or RAM Failures

The TPM logic module (1JKH) in the AT511-A cabinet at location 20 in 1A2A2 contains a RAM to store deadstart programs 0 through 3 and the reconfiguration status. The logic module also contains a lithium battery with a life of at least 4000 hours to maintain the RAM content and to run the Calendar Clock during 400-Hz power outage.

If either the 400-Hz line voltage is removed long enough to deplete the battery charge or the TPM logic module is removed from its logic cage location, the loss of data is sensed and the following actions occur when the logic module receives power.

NOTE

The system console should remain powered up if the TPM is to be removed from its logic cage position, otherwise the remote access password and parameters, the console password, the telephone list, and the communication parameters will be lost. If this information is lost, it will either have to be reentered when the console is initialized or the console will assume the default settings are to be used.

- Deadstart programs 0 through 3 are erased and replaced with a 000300 content in word 1 and all zeros in each remaining word.
- Reconfiguration and other parameters are set to default values.
- The time-of-day is erased, and a status bit is set to indicate to software that a loss of time data has occurred. The year is set to 88.
- If Ctrl-F2 is entered, the Maintenance Options display is brought up instead of the Deadstart Options display, and the following messages are displayed for a battery fault:

```
BATTERY FAILURE
RE-ENTER DS PROGRAMS
```

Or the following message is displayed for a TPM RAM fault:

```
RE-ENTER DS PROGRAMS
```

These messages, as applicable, are removed when the first entry is typed into the deadstart program on the screen.

AT511-A/AT512-A Maintenance Aids

8

Special Tools, Test Equipment, and Materials 8-1

This chapter contains tables that complement the maintenance procedures in chapter 10 of this manual.

Special Tools, Test Equipment, and Materials

Tables 8-1, 8-2, and 8-3 list special tools, test equipment, and materials, respectively, that are used when performing maintenance on an AT511-A/AT512-A type IOU.

Table 8-1. Special Tools

Part Number	Description	How/When Used
00182131	Probe light bulb	Replacement bulb for probe light
00182425	Backpanel repair parts kit	Replacing connector pins and insulators in backpanel
00205366	Backpanel repair tool kit (pin removal tool, pin extraction tool, pin insertion tool, seating blade, insulator puller, Allen drive tool)	Removing and replacing connector pins and insulators in backpanels
00219797	Module insertion tool	Installing logic modules
00219007	Probe light	Troubleshooting backpanels
00219314	Wire spreader rod	Spreading wires on backpanel
00219417	Light stick (battery)	Backpanel troubleshooting
12205640	Torque wrench, 113 N·m (1000 lbf·in)	Torquing diodes in heat sink and installing SCRs
12210794	Spring hook	Probing backpanel wire mats
12210926	Torque wrench, 17 N·m (150 lbf·in)	Torquing diode lead connections and mounting circuit breakers, transformers, and relays in power distribution box
12215145	High-intensity light	Probing backpanel wire mats
12259111	Wire-wrap gun and bits	Replacing a wire-wrap connection on a backpanel pin

(Continued)

Table 8-1. Special Tools *(Continued)*

Part Number	Description	How/When Used
12259183	Wire-unwrap tool (30 gauge)	Removing a wire-wrap connection on a backpanel pin
12262555	Wire stripper (30 gauge)	Removing insulation from a wire before connecting it to a backpanel pin
12263227	Modified 1-1/8-in deep socket	Installing power supply diodes
12263442	Modified 1-1/4-in deep socket	Installing power supply diodes
12263495	Antistatic work pad	Protecting parts from electrostatic discharge during repair
12263496	Antistatic wrist strap, large	Grounding maintenance personnel while working on equipment
12263499	Antistatic bag, 35 mm by 45 mm (14 in by 18 in)	Protecting small parts from electrostatic discharge during handling and transporting
12263623	Antistatic wrist strap, small	Grounding maintenance personnel while working on equipment
53705665	Backpanel repair tool kit	Removing and replacing backpanel pins
53812060	Backpanel repair parts kit	Replacing connector pins and insulators in backpanels
75447668	Antistatic lab coat (size 38)	Whenever maintenance personnel are working in electrostatic sensitive areas
75447669	Antistatic lab coat (size 42)	
75447670	Antistatic lab coat (sizes 44 through 46)	

Table 8-2. Test Equipment

Part Number	Description	How/When Used
00219329	Fluke meter probe	Modified probe used with digital multimeter
00219490	Active scope probe	Connecting oscilloscope to circuit under test
12263230	Polarized collapsible viewing hood	Viewing faint signals on oscilloscope
12263279	Digital multimeter (Fluke 8020A)	General
12263423	Scope probe (X10) (Tektronix P6056)	Connecting oscilloscope to circuit under test
12263632	Oscilloscope (Tektronix 2465 with option 11)	Troubleshooting
12263633	Termination (50 ohm)	Connecting 50-ohm probes to channels 3 and 4 of scope
18697523	Scope probe hook tip	Connecting oscilloscope to test points
53592086	Manifold strain relief	Providing strain relief for test equipment leads

Table 8-3. Materials

Part Number	Description	How/When Used
12263294	Solvent spray brush (for spray can)	Cleaning logic modules
12263512	Freon TMS solvent (16-oz spray can)	Cleaning logic modules
12263513	Trichloroethane solvent	Cleaning logic modules
22704200	Electrical joint compound (EJC No. 2)	Installing transformers and diodes
94211400	Lint-free disposable cloths	Cleaning logic modules
94657900	Thermal grease (GE641)	Installing thermostats, diodes, and SCRs

AT511-A/AT512-A Preventive Maintenance **9**

Air Filter Check	9-1
Noise/Vibration Check	9-1
Cabinet Voltage Level Verification	9-1

AT511-A/AT512-A Preventive Maintenance 9

The following preventive maintenance tasks should be performed during a convenient period of corrective maintenance.

Air Filter Check

Each IOU cabinet has an air filter located immediately below the lower row of the logic cage. Slide the filter from its rack from the front of the cabinet. Use a vacuum cleaner to clean the filter. If excessive deposits require, wash the filter in a solution of warm water and household detergent, rinse it with plain water, and dry thoroughly.

Noise/Vibration Check

Each IOU cabinet has a blower assembly located at the top of the cabinet. If blower operation is accompanied by excessive noise and/or vibration, inspect the blower and blower chamber for either the presence of a foreign object or a faulty blower assembly (refer to Cabinet Blower Assembly Removal/Replacement procedure in chapter 10).

Cabinet Voltage Level Verification

Use this procedure to check that cabinet bus voltages have not changed.

- ___ 1. With power applied to the IOU cabinet to be checked, set power distribution box METER SELECT switch to OFF.
- ___ 2. Observe that meter needle rests on left indicator line. If necessary, adjust needle to line with screw on front of meter.
- ___ 3. Set METER SELECT to V1, and ensure that meter indicates 0 percent.
- ___ 4. Set METER SELECT to V2, and ensure that meter indicates 0 percent.
- ___ 5. Set METER SELECT to V3, and ensure that meter indicates 0 percent.
- ___ 6. If any requirement is not met, perform IOU Cabinet Bus Voltage Adjustment procedure in chapter 10.

AT511-A/AT512-A Corrective Maintenance 10

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AT511-A/AT512-A Corrective Maintenance 10

This chapter contains step-by-step procedures for activities that might result in physical injury, equipment damage, or lost time without the use of specific instructions. Most of the procedures describe how to replace field replaceable units (FRUs), but there are also procedures for handling electrostatic sensitive parts, cleaning logic modules, and testing selected electrical devices.

Before performing a procedure, read through it to determine the need for special tools, test equipment, materials, and skills.

⚠ WARNING

The procedures in this manual were verified on the equipment under strictly controlled conditions. Any deviation from the procedures may result in personal injury or damage to the equipment.

Since most of the procedures specify removing and applying power to the system or to individual system cabinets, you should be familiar with power-on and power-off procedures before performing maintenance.

⚠ WARNING

To prevent exposure to hazardous voltages, any power removed during a removal procedure must remain removed during the replacement procedure. The procedures assume that replacement directly follows removal and, therefore, do not repeat the power removal steps in the replacement procedures.

Simple activities like opening and closing cabinet doors are normally part of every removal and replacement action. Since all trained maintenance people know how to perform them, these activities are not included in the procedures to avoid unnecessary repetition.

Procedures

The following paragraphs describe the procedures used to maintain an IOU.

Antistatic Wrist Strap Test

Use this procedure to test the performance of an antistatic wrist strap and its grounding cord.

Tools/parts required

- A locally prepared electrode to be held by the person wearing the wrist strap. A 75 mm (3 in) length of #304 stainless steel, roundstock that is 25 mm (1 in) in diameter and has either a banana plug receptacle or a screw connector attached to one end.
- An ohmmeter capable of measuring high resistance (0 to 100 megohms) with enough voltage to overcome skin resistance. Suggested meters include the Simpson Model 269 (20 V at 0.2 μ A) and the Triplet Model 630PL (30 V at 0.3 μ A).
- Antistatic wrist strap with grounding cord. Either large size (CDC P/N 12263496) or small size (CDC P/N 12263623) as required.

Procedure

- ___ 1. Zero the ohmmeter.
- ___ 2. Put antistatic wrist strap around wrist.
- ___ 3. Attach ground lead of ohmmeter to banana plug end of wrist strap grounding cord.
- ___ 4. Attach positive lead of ohmmeter to electrode.
- ___ 5. Holding electrode in hand, rotate wrist to simulate normal working motion while observing resistance measurement on meter. Hold metal tab on wrist strap away from wrist to ensure metal fibers in strap are being tested without benefit of tab. Resistance must be between 0.6 megohm and 5 megohm. The 0.6-megohm level provides adequate current limiting protection for wearer.
- ___ 6. If resistance value is not within the specified level, check wrist strap and grounding cord separately to locate cause.
- ___ 7. If wrist strap fails, wash it in soapy water and repeat steps 1 through 5. If wrist strap fails again, wash it or replace it.

Static-Sensitive Parts Handling

Use this procedure to avoid static discharge that destroys static-sensitive parts. Static sensitive parts include most semiconductor devices and assemblies.

Tools/parts required

- Antistatic wrist strap with grounding cord. Either large size (CDC P/N 12263496) or small size (CDC P/N 12263623) as required.
- Antistatic bag, CDC P/N 12263499
- Antistatic work pad, CDC P/N 12263495
- Antistatic lab coat. Either size 38 (CDC P/N 75447668), size 42 (CDC P/N 5447669), or sizes 44 through 46 (CDC P/N 75447670)
- Antistatic floor mat

Part removal/replacement

- ___ 1. Obtain antistatic bag in which to place part to be removed.
- ___ 2. Stand on antistatic floor mat.
- ___ 3. Put on antistatic wrist strap and connect wrist strap grounding cord to equipment ground.
- ___ 4. Touch metal frame of equipment before touching part.
- ___ 5. Remove part and place it in antistatic bag before stepping off mat or removing wrist strap.

Parts handling at repair station

- ___ 1. Place part, contained in antistatic bag, on work surface fitted with antistatic pad connected to raised-floor grid ground.
- ___ 2. Put on antistatic wrist strap and connect wrist strap grounding cord to repair station ground.
- ___ 3. Sit at repair station.
- ___ 4. Remove part from antistatic bag.
- ___ 5. After repairing part, replace it in antistatic bag before removing wrist strap.

Logic Module Cleaning

Use this cleaning procedure to remove foreign substances from the edgeboard pins or flux from the solder connections of a logic module.

Tools/parts required

- Lint-free disposable cloths, CDC P/N 94211400
- Trichloroethane solvent (16-oz) spray can, CDC P/N 12263513
- Solvent spray brush, CDC P/N 12263294
- Disposable absorbent tissues
- Freon¹ TMS solvent (16-oz) spray can, CDC P/N 12263512

CAUTION

Avoid destroying static sensitive parts by handling logic modules according to Static-Sensitive Parts Handling.

Edgeboard pins

- ___ 1. Clean edgeboard pins using lint-free disposable cloth moistened with trichloroethane solvent.
- ___ 2. To avoid snagging cloth fibers on pins or other sharp points near connector edge of module, use wiping motion that is parallel to pins and goes off end of pins.

Solder connections

NOTE

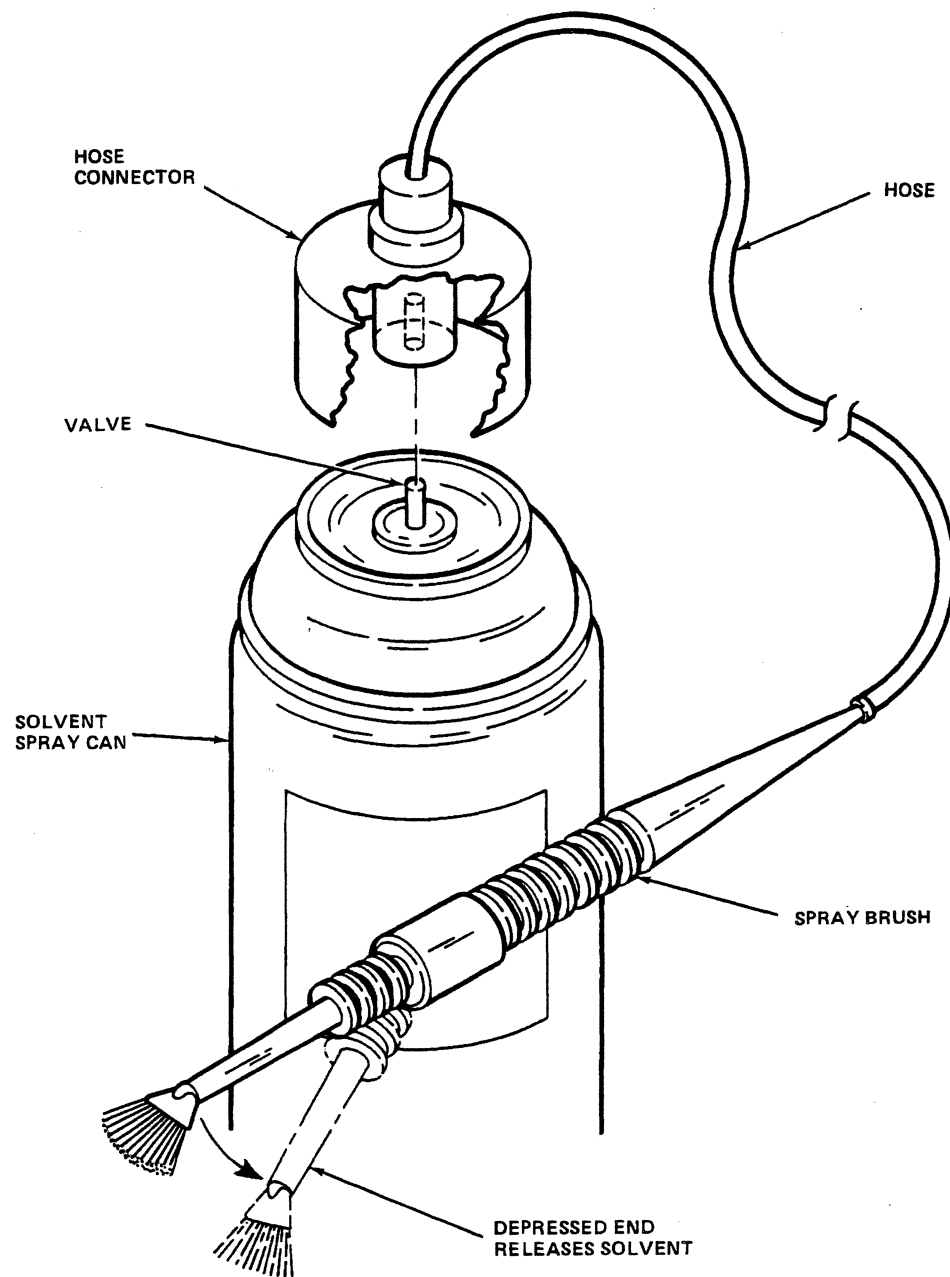
Clean logic module immediately after completion of fluxing or soldering.

- ___ 1. Remove cover and spray tip from spray can of trichloroethane.
- ___ 2. Press hose connector of spray brush onto valve of solvent spray can. Pressurize solvent flows to spray brush (figure 10-1).

NOTE

Pressing on lower end of brush releases solvent from brush.

1. Freon is a trade name for refrigerants made by E. I. Dupont de Nemours and Company.



00135-1

Figure 10-1. Module Cleaning Materials

- ___ 3. Place several layers of disposable absorbent wipers on work surface.
- ___ 4. Place edge of logic module on wipers and hold it at an angle to allow sprayed solvent to run onto wipers.
- ___ 5. Remove all traces of flux and particles by spraying and brushing fluxed area of module.
- ___ 6. Dry module in air for approximately 2 minutes.
- ___ 7. Thoroughly flush module and components by spraying area being cleaned with Freon TMS solvent.
- ___ 8. Dry module in air for approximately 2 minutes.
- ___ 9. Dispose of wipers.
- ___ 10. Release pressure in hose and spray brush before storage by removing hose connector from solvent spray can.

IOU Power Removal/Application

Before removing or replacing components mounted in the IOU, power must be removed from the cabinet containing the components. Controls for removing and applying 400-Hz and 50/60-Hz power are located on the power distribution box, which is accessed from the front of the cabinet.

Remove power

- ___ 1. Set 400 Hz MAIN DISCONNECT circuit breaker on front of power distribution box to OFF (down).
- ___ 2. Set 50/60 Hz DISCONNECT circuit breaker on front of power distribution box to OFF (down).
- ___ 3. When performing removal/replacement procedure on the power distribution box, set 400-Hz and 50/60-Hz circuit breakers to OFF at source (wall).

⚠ WARNING

If repairs are to be made to power distribution box, remove 400-Hz and 50/60-Hz power from cabinet by turning circuit breakers off at source (wall).

Apply power

- ___ 1. When performing removal/replacement procedure on power distribution box, set 400-Hz and 50/60-Hz circuit breakers to ON at source (wall).
- ___ 2. Set 50/60 Hz DISCONNECT circuit breaker on front of power distribution box to ON (up).
- ___ 3. Set 400 Hz MAIN DISCONNECT circuit breaker on front of power distribution box to ON (up).

Backpanel Wire-Wrap Connection Removal/Replacement

Use this procedure to remove and/or replace a wire-wrap connection on a backpanel pin.

Tools/parts required

- Wire-unwrap tool (30 gauge), CDC P/N 12259183
- Wire-wrap gun and bits, CDC P/N 12259111
- Wire stripper (30 gauge), CDC P/N 12262555

Removal

- ___ 1. Remove power from cabinet containing wire to be removed according to IOU Power Removal/Application.
- ___ 2. Place end of wire-unwrap tool on end of wire-wrap pin that requires wire removal (figure 10-2).
- ___ 3. Push wire-unwrap tool gently toward backpanel while twisting tool counterclockwise.
- ___ 4. Pull tool and wire carefully from wire-wrap pin when wire loosens or unwraps.

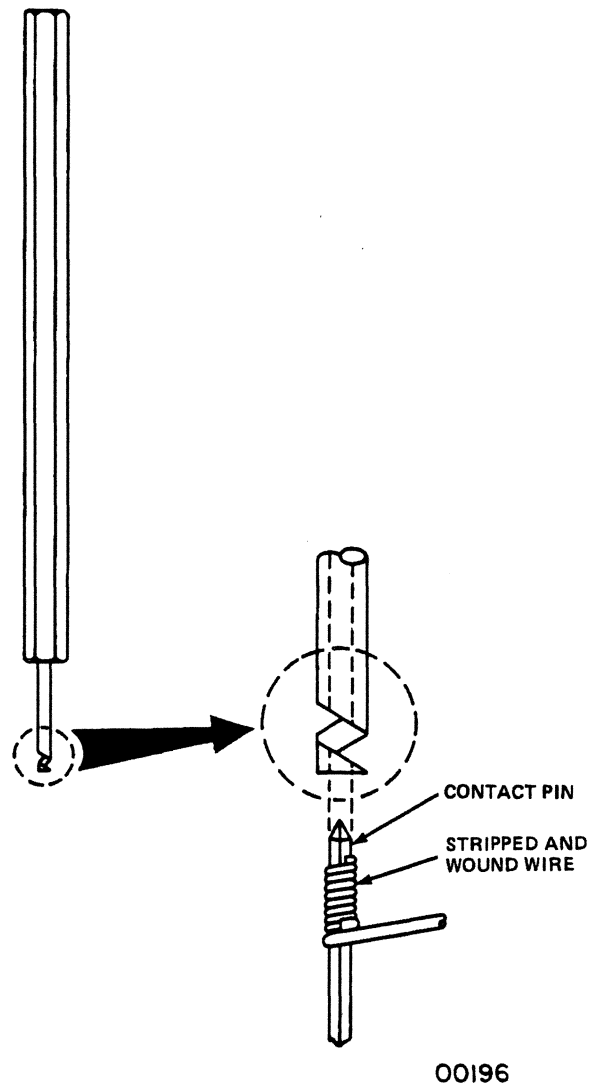
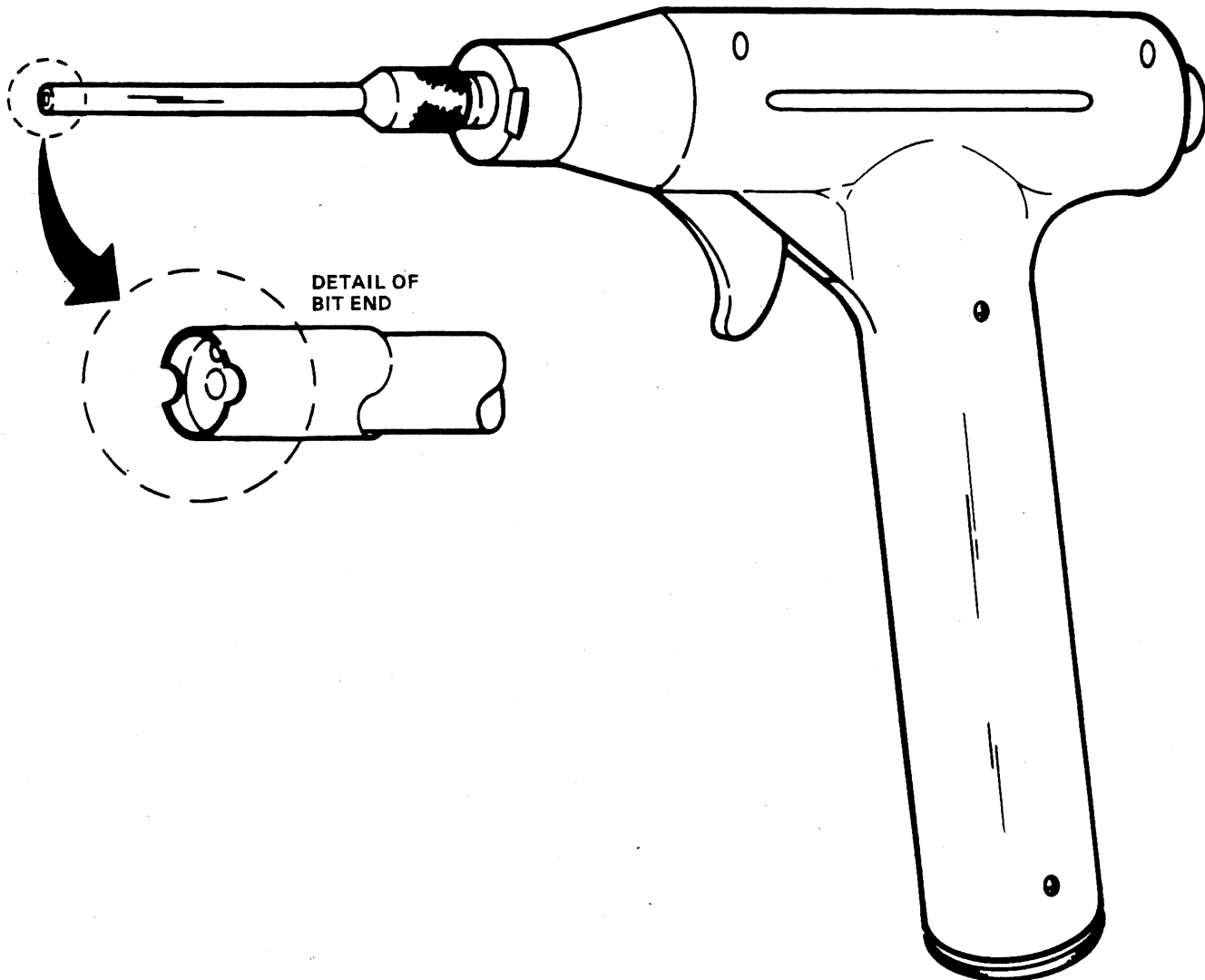


Figure 10-2. Wire-Unwrap tool

Replacement

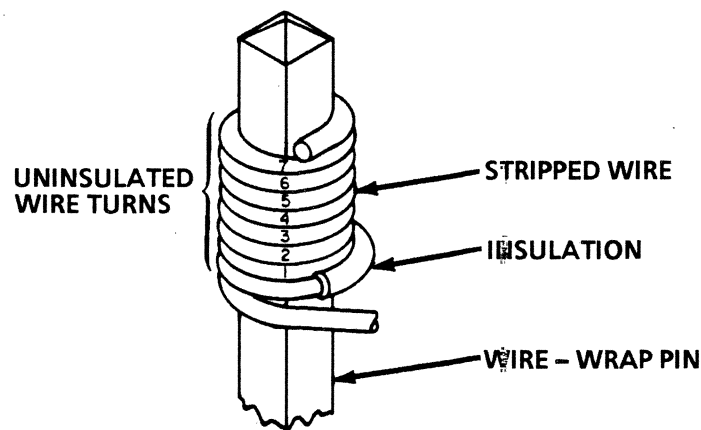
- ___ 1. Select a wire-wrap bit that fits backpanel pin and size of wire being replaced. Install bit on wire-wrap gun (figure 10-3).
- ___ 2. Use wire stripper to strip about 25 mm (1 in) of insulation from end of wire to be wrapped.
- ___ 3. Insert stripped end of wire as far as it will go into small hole in wire-wrap bit.
- ___ 4. Bend wire across end of bit and back against bit shaft, holding wire against shaft.



00197

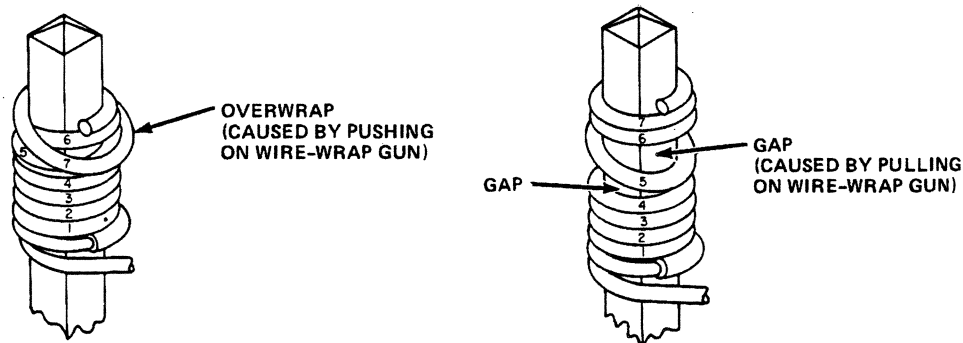
Figure 10-3. Wire-Wrap Bit Detail

- ___ 5. Place large hole in end of bit over wire-wrap pin while keeping wire-wrap gun in line with pin.
- ___ 6. Apply power to wire-wrap gun. Allow gun to back off pin during wire-wrapping process without pushing or pulling gun.
- ___ 7. Remove wire-wrap gun completely from pin. A correctly wound wire is tight on pin with seven turns of bare wire and one turn of insulated wire (figure 10-4). An incorrectly wound wire has overlap, is loosely wound, or has gaps between adjacent turns (figure 10-5).
- ___ 8. Repeat removal steps 2 through 4 and replacement steps 2 through 7 for an incorrectly wrapped wire.
- ___ 9. Apply power to cabinet according to IOU Power Removal/Application.



00198

Figure 10-4. Correct Wire-Wrap



00199

Figure 10-5. Incorrect Wire-Wrap

Logic Module Removal/Replacement

Use this procedure to remove and replace a logic module.

Tools/parts required

- Antistatic wrist strap with grounding cord. Either large size (CDC P/N 12263496) or small size (CDC P/N 12263623) as required.
- Pak insertion tool, CDC P/N 00219797
- Antistatic bag, CDC P/N 12263499

CAUTION

Avoid destroying static sensitive parts by handling logic modules according to Static-Sensitive Parts Handling.

Removal

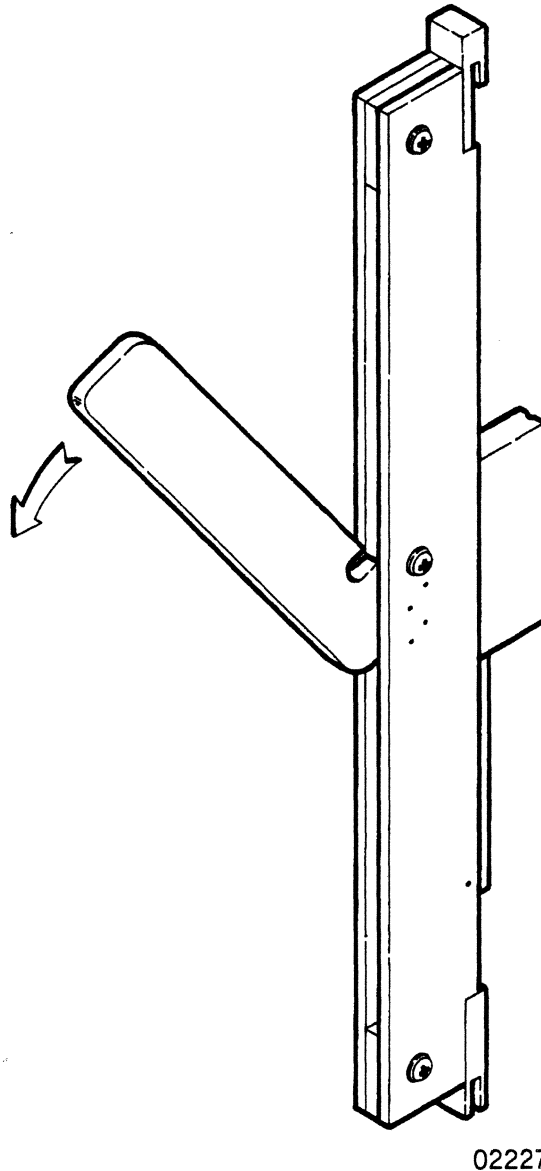
CAUTION

Remove power from cabinet before removing logic module or damage may occur.

- ___ 1. Set MAIN DISCONNECT circuit breaker to off on front of the IOU cabinet containing logic module to be removed.
- ___ 2. Put on antistatic wrist strap and connect it to chassis ground.
- ___ 3. Remove cover from logic cage.
- ___ 4. Pull top and bottom extractors on front of logic module outward at same time and unseat logic module from its connector.
- ___ 5. Remove logic module by sliding it straight out of cabinet.
- ___ 6. Place logic module in an antistatic bag.

Replacement

- ___ 1. Position logic module on guide rods at top and bottom of cabinet slot.
- ___ 2. Slide logic module into slot until it just contacts connector.
- ___ 3. Place module insertion tool on channels at top and bottom of logic cage (figure 10-6). Align moving block of tool with edge of logic module.
- ___ 4. Move tool handle so that tool's moving block seats logic module in connector.
- ___ 5. Replace cover on logic cage.

**Figure 10-6. Module Insertion Tool**

Logic Module Backpanel Pin Removal/Replacement

The logic module backpanel contains several rows of edgeboard connector pins (figure 10-7). Removable insulators cover the pins in each row. Use this procedure to remove and replace insulators and pins.

Tools/parts required

- Backpanel repair tool kit, CDC P/N 00182425
- Sheet of paper
- Plastic-head hammer
- Backpanel repair parts kit, CDC P/N 53812060

Removal

1. Remove power from cabinet containing backpanel to be repaired according to IOU Power Removal/Application.
2. If pin to be replaced is wire-wrapped, remove wire according to Backpanel Wire-Wrap Connection Removal/Replacement procedure.

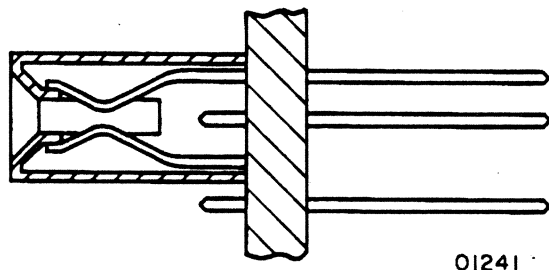
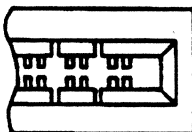
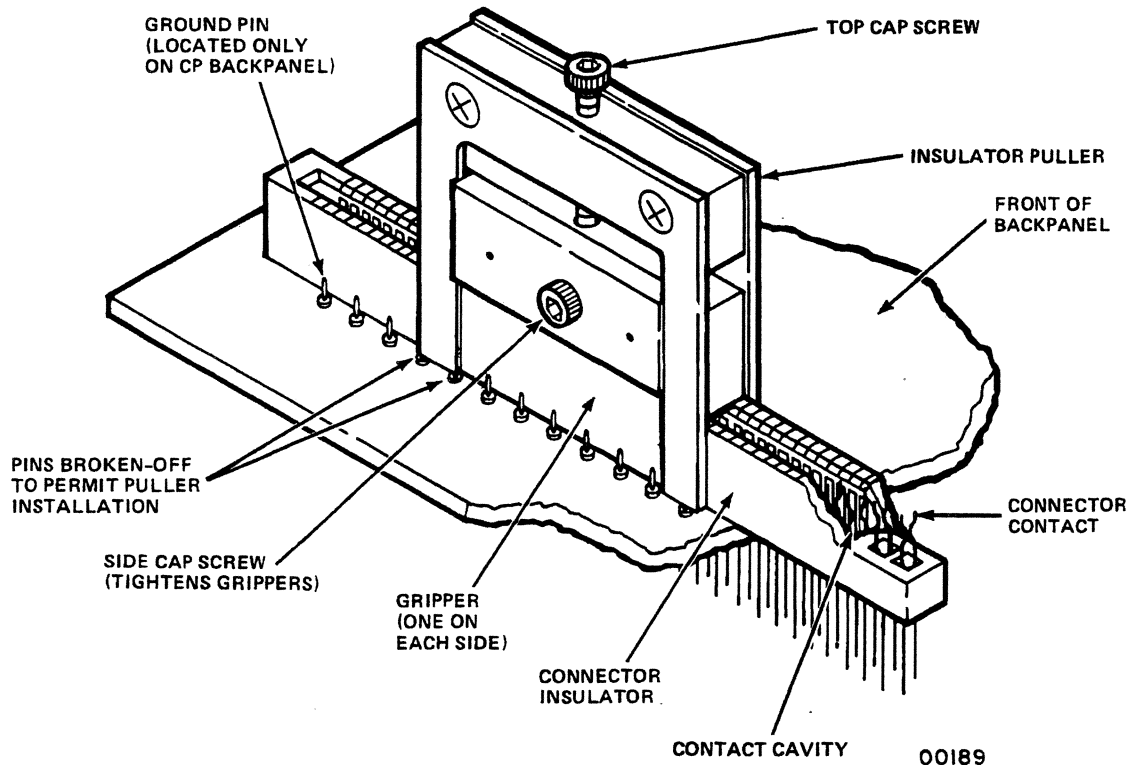


Figure 10-7. Backpanel Pins

- ___ 3. Lower grippers of insulator puller by turning top cap screw with Allen drive tool (both part of backpanel repair tool kit) (figure 10-8).
- ___ 4. Place insulator puller over connector insulator. Tighten grippers on insulator by turning side cap screw with Allen drive tool.
- ___ 5. Remove insulator from backpanel by turning top cap screw.
- ___ 6. Remove insulator from puller by turning side cap screw.

**NOTE:**

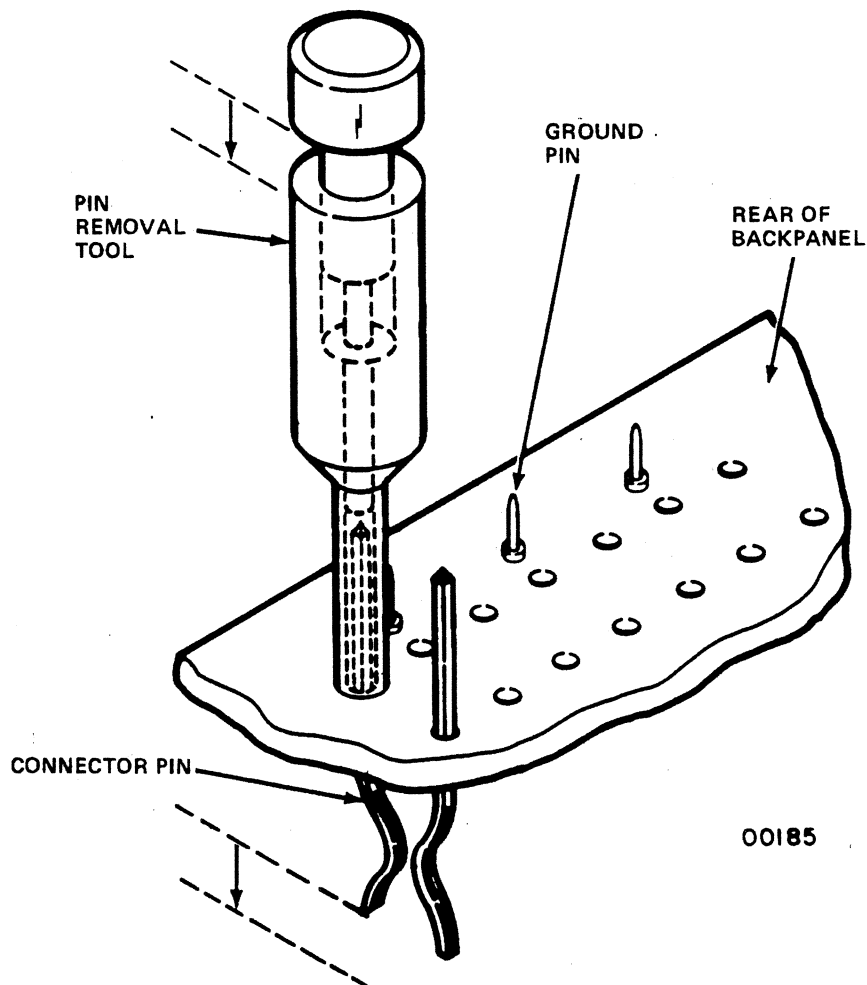
THE INSULATOR PULLER IS PART OF THE CONNECTOR REPAIR KIT.

Figure 10-8. Connector Insulator Removal

- ___ 7. Remove defective pin from backpanel using pin removal tool or pin extraction tool (both part of backpanel repair tool kit).

To use pin removal tool:

- ___ a. Place sheet of paper under front of connector to catch pin.
- ___ b. At rear of backpanel, set pin removal tool over pin to be removed (figure 10-9).
- ___ c. Push pin out of backpanel by tapping end of pin removal tool lightly with plastic-head hammer.
- ___ d. Remove pin from front of backpanel.
- ___ e. Remove sheet of paper.



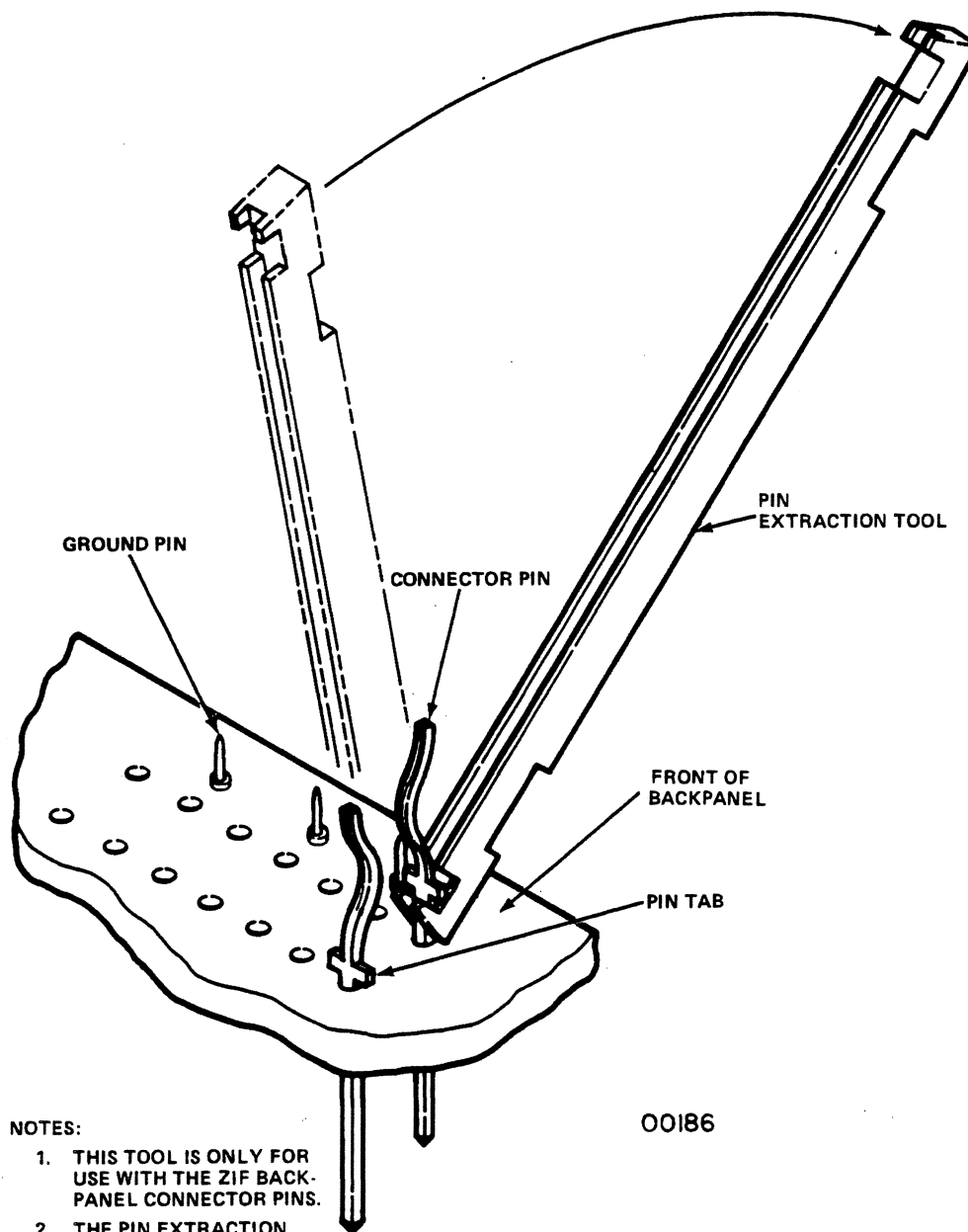
NOTES:

1. THIS PIN REMOVAL TOOL IS FOR USE WITH THE ZIF BACKPANEL CONNECTOR PINS.
2. THE PIN REMOVAL TOOL FOR CM HAS A SLIGHTLY DIFFERENT SHAPE BUT IS USED IN THE SAME WAY.
3. THE PIN REMOVAL TOOL IS PART OF THE CONNECTOR REPAIR KIT.

Figure 10-9. Pin Removal Tool

To use pin extraction tool:

- ___ a. At front of backpanel, insert small hooks of pin extraction tool under tabs of pin to be removed (figure 10-10).
- ___ b. Start pin removal by pivoting tool against backpanel and away from pin.
- ___ c. Insert large hooks of pin extraction tool under tabs of pin.
- ___ d. Finish pin removal by pivoting tool against backpanel and away from pin.



NOTES:

1. THIS TOOL IS ONLY FOR USE WITH THE ZIF BACK-PANEL CONNECTOR PINS.
2. THE PIN EXTRACTION TOOL IS PART OF THE CONNECTOR REPAIR KIT.

Figure 10-10. Pin Extraction Tool

Replacement

1. Select replacement pin from backpanel repair parts kit (figure 10-11).

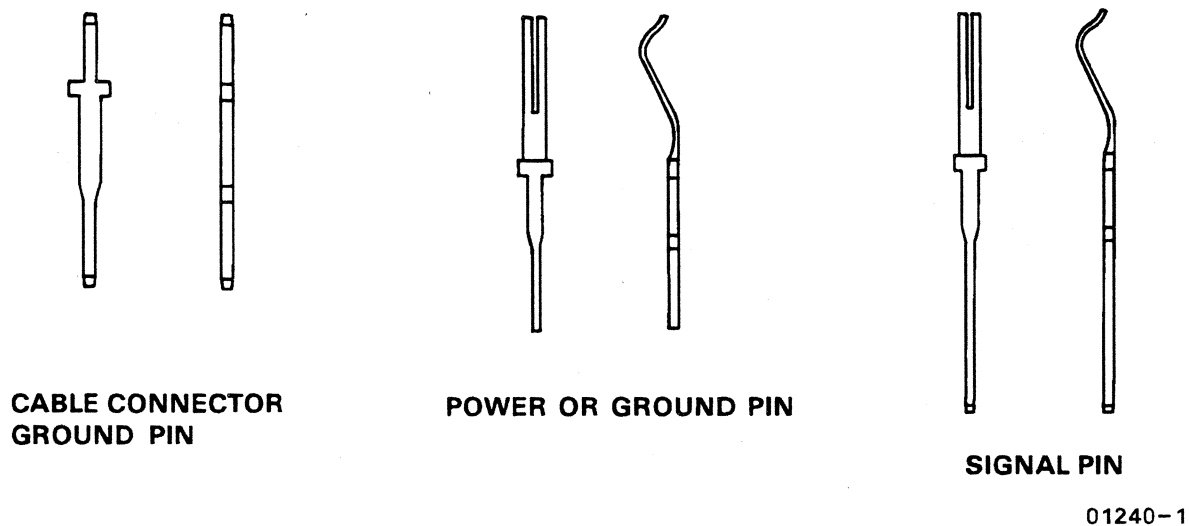


Figure 10-11. Replacement Pins

- 2. Place pin in pin insertion tool (part of backpanel repair tool kit). Hold top of pin in tool with finger (figure 10-12).
- 3. Insert pin into backpanel as far as it will go without forcing it.
- 4. Tap pin insertion tool lightly with plastic-head hammer until pin is fully seated in backpanel.

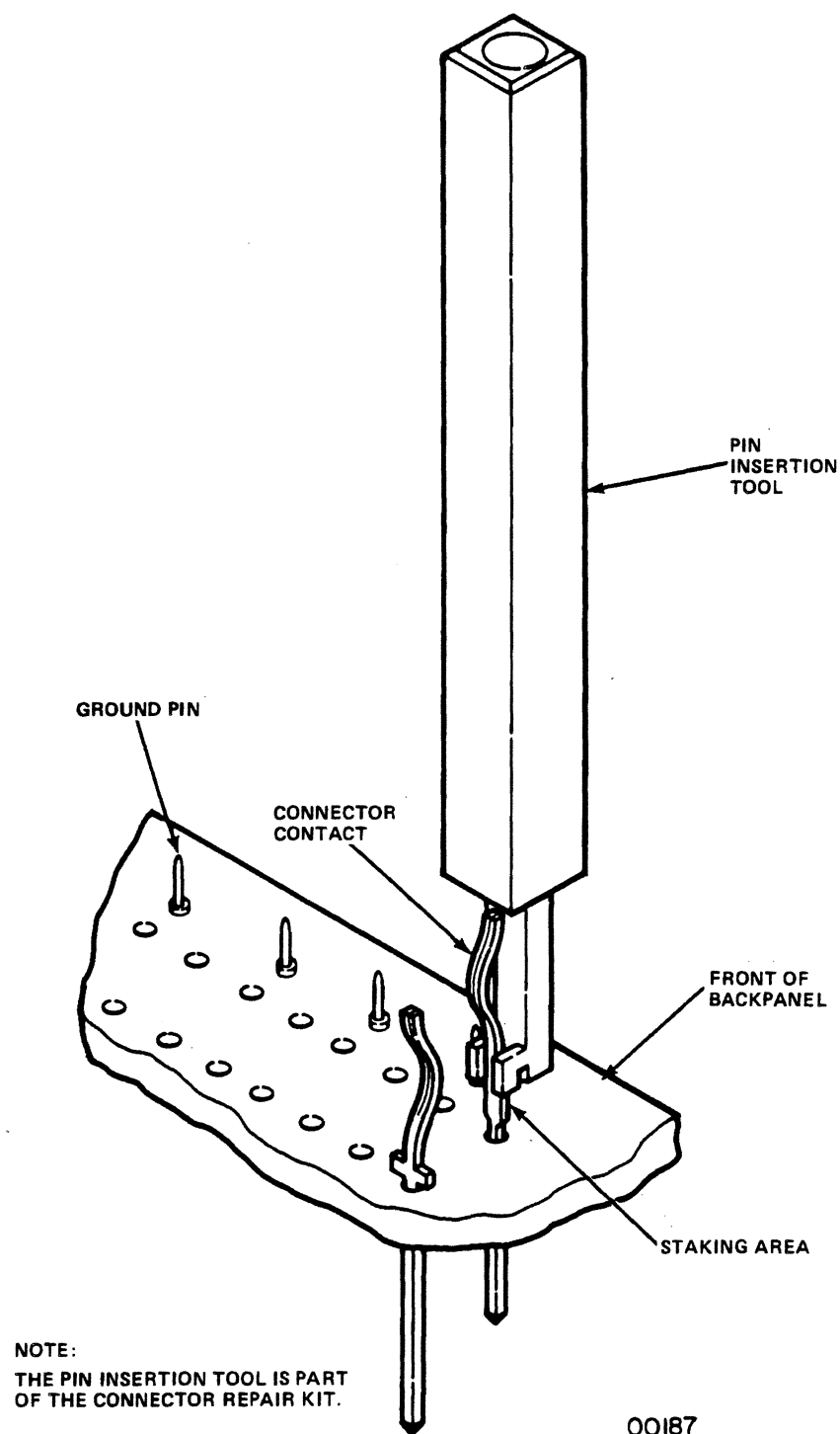


Figure 10-12. Pin Insertion Tool

- ___ 5. Remove tool and inspect pin. If pin is aligned with other pins, go to next step. Otherwise, replace pin again.

NOTE

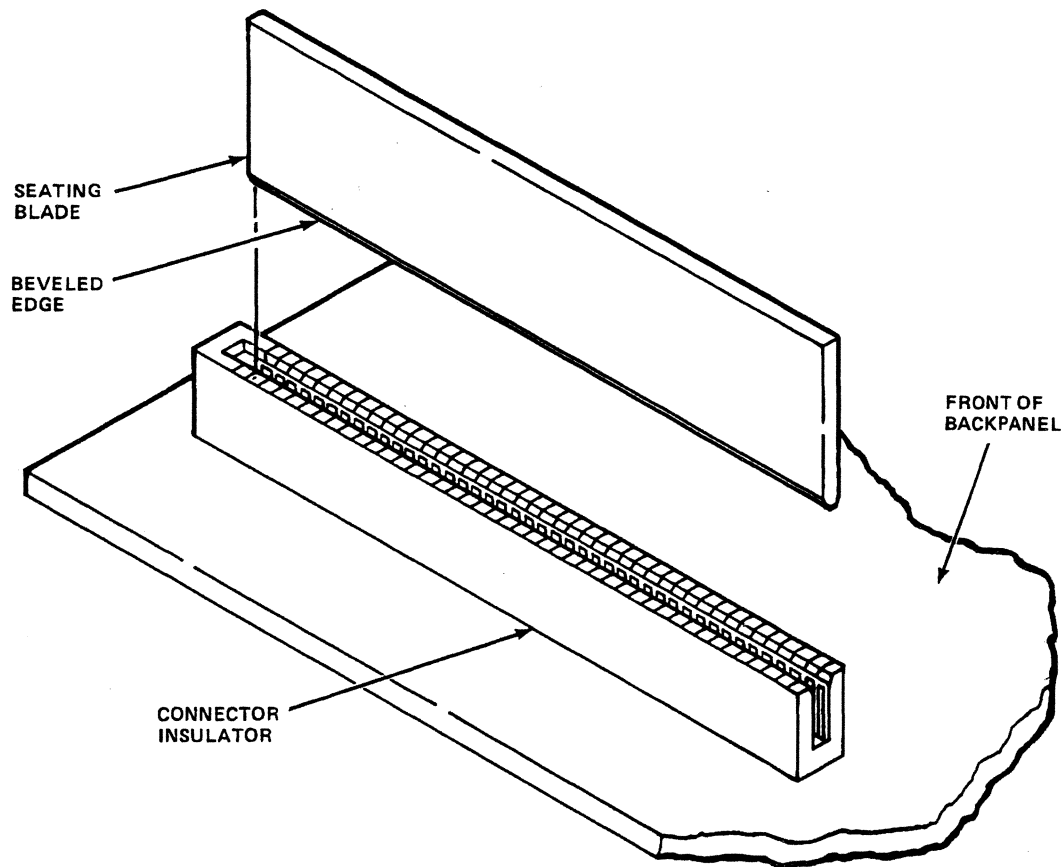
To ensure a tight fit over the pins, use a replacement insulator from the backpanel repair parts kit.

- ___ 6. Select replacement insulator from backpanel repair parts kit. Position insulator loosely over pins.
- ___ 7. Inspect pins through opening in insulator. If all pins are uniformly in place, go to next step. Otherwise, replace bent pins.

⚠ CAUTION

Do not apply any pressure on the replacement insulator. Applying pressure on the insulator severely damages the pins under the insulator that have not been aligned and spread (steps 8 and 9).

- ___ 8. Align pins in cavities of insulator by lightly inserting beveled edge of seating blade into insulator with rocking motion (figure 10-13). Seating blade is part of backpanel repair tool kit.
- ___ 9. Spread pins in cavities of insulator by pressing firmly on top of seating blade, sliding it between rows of pins to bottom of insulator.
- ___ 10. Seat insulator on pins by sharply tapping seating blade several times with plastic-head hammer.
- ___ 11. Remove seating blade from insulator.
- ___ 12. Inspect insulator and pins. Insulator must be flush with backpanel undamaged. Pins must be aligned with cavities and with each other.
- ___ 13. If pin is supposed to have wire wrapped to it, strip and install wire according to Backpanel Wire-Wrap Connection Removal/Replacement procedure.
- ___ 14. Apply power to cabinet according to IOU Power Removal/Application.



SEATING BLADE IS PART OF THE CONNECTOR REPAIR KIT.

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Figure 10-13. Connector Insulator Installation

-2.2 V Transformer Removal/Replacement

Use this procedure to remove and/or replace transformer 1T1 (-2.2 V) from an IOU cabinet.

Tool/parts required

- Phillips screwdriver
- Flat-blade screwdriver
- 3/8-in socket set
- Electrical joint compound (EJC No. 2), CDC P/N 22704200
- Torque wrench 16.5 N·m (150 lbf·in), CDC P/N 12210926

Removal

- ___ 1. Remove power from cabinet containing transformer to be replaced according to IOU Power Removal/Application.
- ___ 2. Remove screws and transformer support bracket connecting outboard ends of transformers together.
- ___ 3. Remove cover from transformer 1T1 terminal board. Label lead wire connections and disconnect lead wires at terminal board (figure 10-14).
- ___ 4. Remove screws, nuts, and washers securing white feeder bus to center tap bar of transformer 1T1.
- ___ 5. Remove SCR flexible power lead from center tap bar of transformer 1T1.
- ___ 6. Label connections and remove nuts and washers securing diode leads to transformer 1T1 secondary terminals on side of transformer.
- ___ 7. Unlock power distribution box (remove screw from bracket on front-lower corner) and swing it out from cabinet front.
- ___ 8. Remove Torx-head screws securing transformer 1T1 to chassis vertical heat sink weldment.

⚠ WARNING

The transformer weighs 35 kg (77 lb), and requires two persons to move.

- ___ 9. Lift transformer out of cabinet rear.

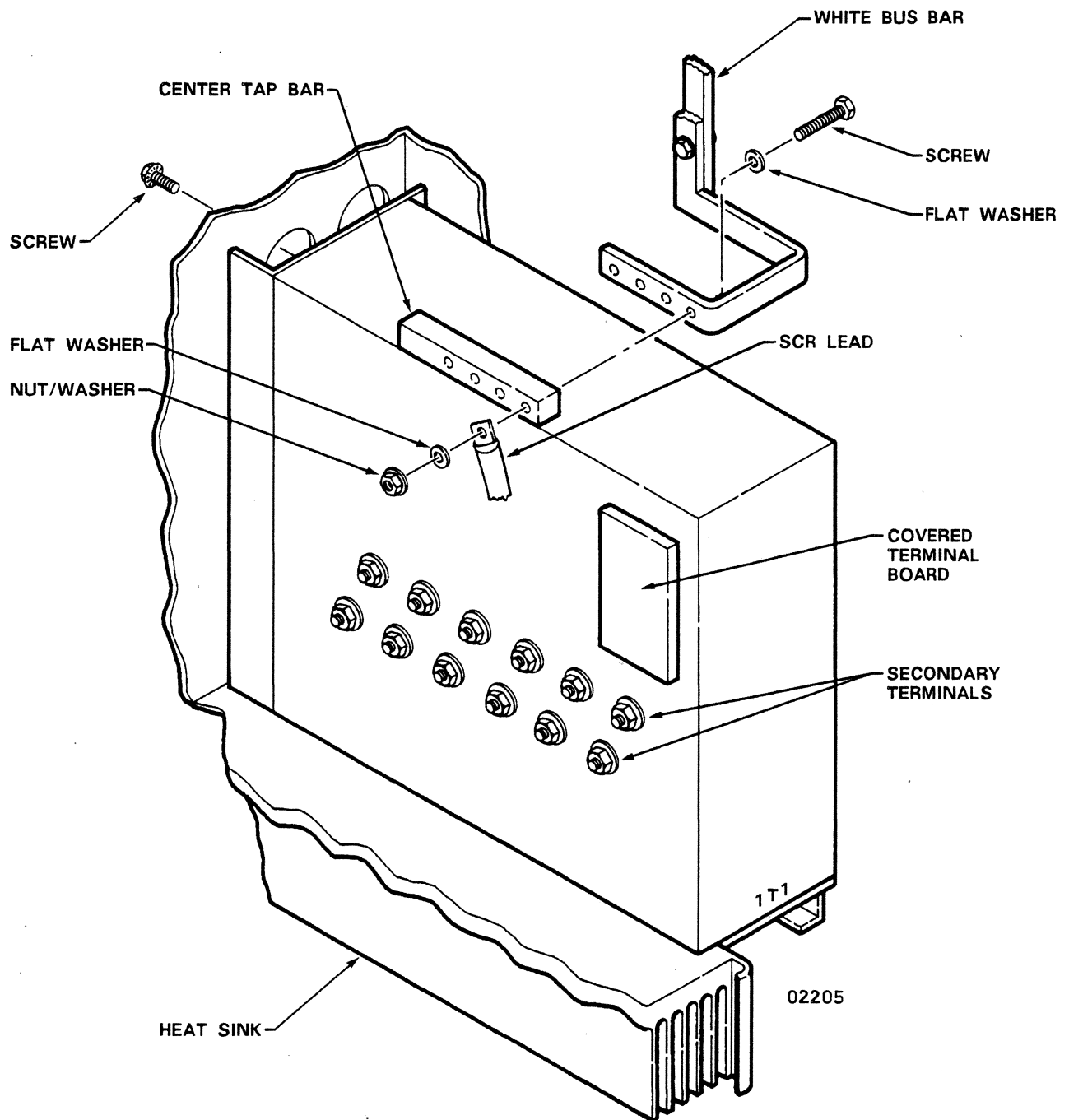


Figure 10-14. 1T1 Transformer

Replacement

Perform steps of removal procedure in reverse order.

NOTE

Ensure that rubber strips are in place beneath and behind the transformer. Lightly coat bus to center tap bar connection and diode lead to transformer side stud connections with electrical joint compound. Torque nuts that connect diode leads to transformer side lugs and nuts that secure bus to center tap bar to 14.6 N·m (130 lbf·in).

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-5.2 V Transformer Removal/Replacement

Use this procedure to remove and/or replace transformer 1T3 (-5.2 V) from an IOU cabinet.

Tool/parts required

- Phillips screwdriver
- Flat-blade screwdriver
- 3/8-in socket set
- Electrical joint compound (EJC No. 2), CDC P/N 22704200
- Torque wrench 16.5 N•m (150 lbf•in), CDC P/N 12210926

Removal

- ___ 1. Remove power from cabinet containing transformer to be replaced according to IOU Power Removal/Application.
- ___ 2. Remove screws and transformer support bracket connecting outboard ends of transformers together.
- ___ 3. Remove cover from transformer 1T3 terminal board. Label lead wire connections and disconnect lead wires at terminal board (figure 10-15).
- ___ 4. Remove screws, nuts, and washers securing blue feeder bus to center tap bar of transformer 1T3.
- ___ 5. Remove SCR flexible power lead from center tap bar of transformer 1T3.
- ___ 6. Label connections and remove nuts securing diode leads to transformer 1T3 secondary terminals on both sides of transformer.
- ___ 7. Remove screws, spacers, and washers securing transformer to horizontal heat sink weldment.

⚠ WARNING

The transformer weighs 50 kg (110 lb), and requires two persons to move.

- ___ 8. Lift transformer out of cabinet rear.

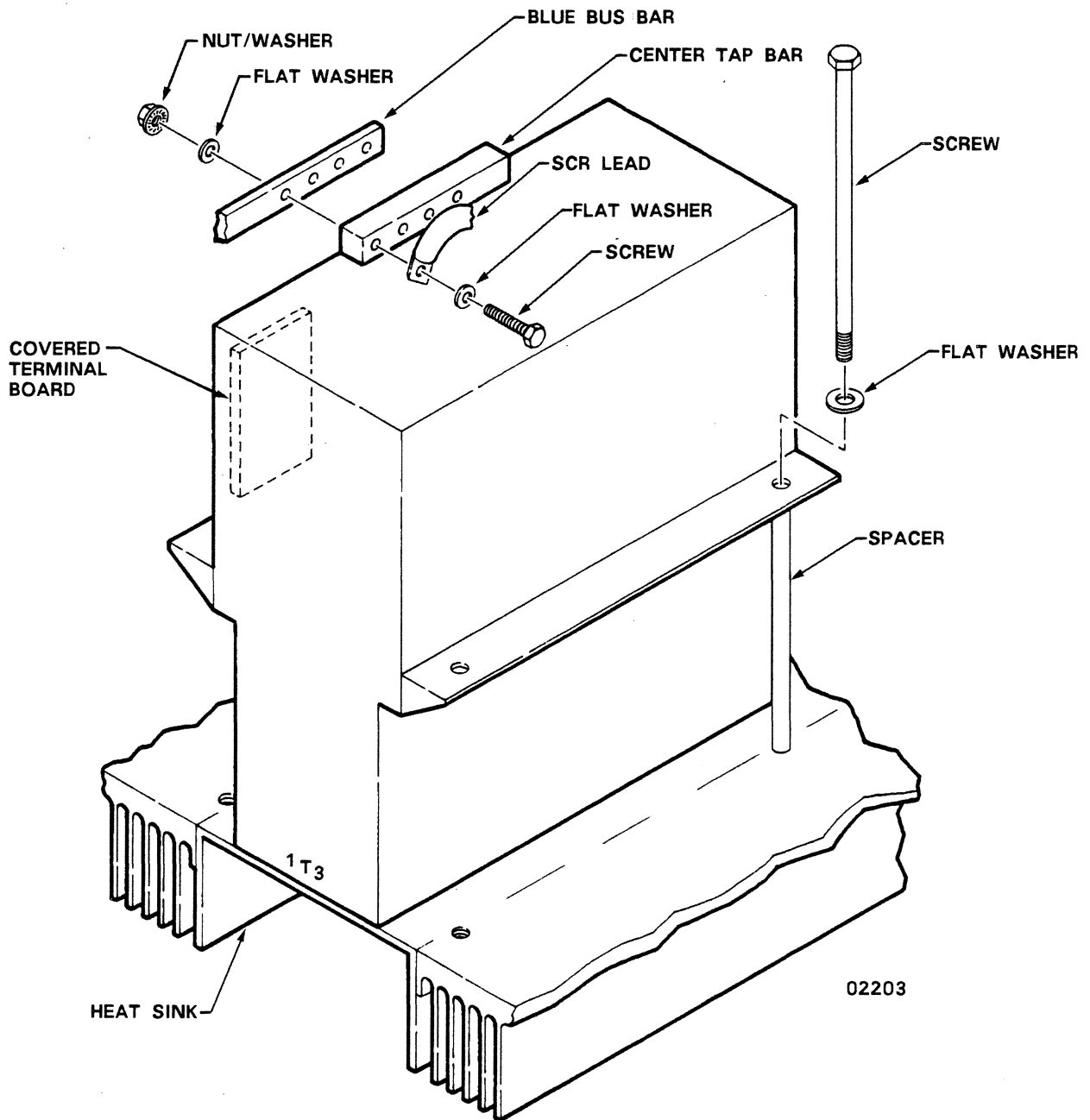


Figure 10-15. 1T3 Transformer

Replacement

Perform steps of removal procedure in reverse order.

NOTE

Ensure that rubber strips are in place beneath the transformer. Lightly coat bus to center tap bar connection and diode lead to transformer side stud connections with electrical joint compound. Torque nuts that connect diode leads to transformer side lugs and nuts that secure bus to center tap bar to 14.6 N·m (130 lbf·in).

+5.0 V Transformer Removal/Replacement

Use this procedure to remove and/or replace transformer 1T2 (+5.0 V) from an IOU cabinet.

Tool/parts required

- Phillips screwdriver
- Flat-blade screwdriver
- 3/8-in socket set
- Electrical joint compound (EJC No. 2), CDC P/N 22704200
- Torque wrench 16.5 N·m (150 lbf·in), CDC P/N 12210926

Removal

- ___ 1. Remove power from cabinet containing transformer to be replaced according to IOU Power Removal/Application.
- ___ 2. Remove screws and transformer support bracket connecting outboard ends of transformers.
- ___ 3. Remove cover from transformer 1T2 terminal board. Label lead wire connections and disconnect lead wires at terminal board (figure 10-16).
- ___ 4. Remove screws, nuts, and washers securing red feeder bus to center tap bar of transformer 1T2.
- ___ 5. Label connections and remove nuts securing diode leads to transformer 1T2 secondary terminals on side of transformer.
- ___ 6. Unlock power distribution (remove screw from bracket on front lower-left corner) box and swing it out from cabinet front.
- ___ 7. Remove Torx-head screws securing transformer 1T2 to chassis vertical heat sink weldment.

WARNING
--

The transformer weighs 35 kg (77 lb), and requires two persons to move.

- ___ 8. Lift transformer out of cabinet rear.

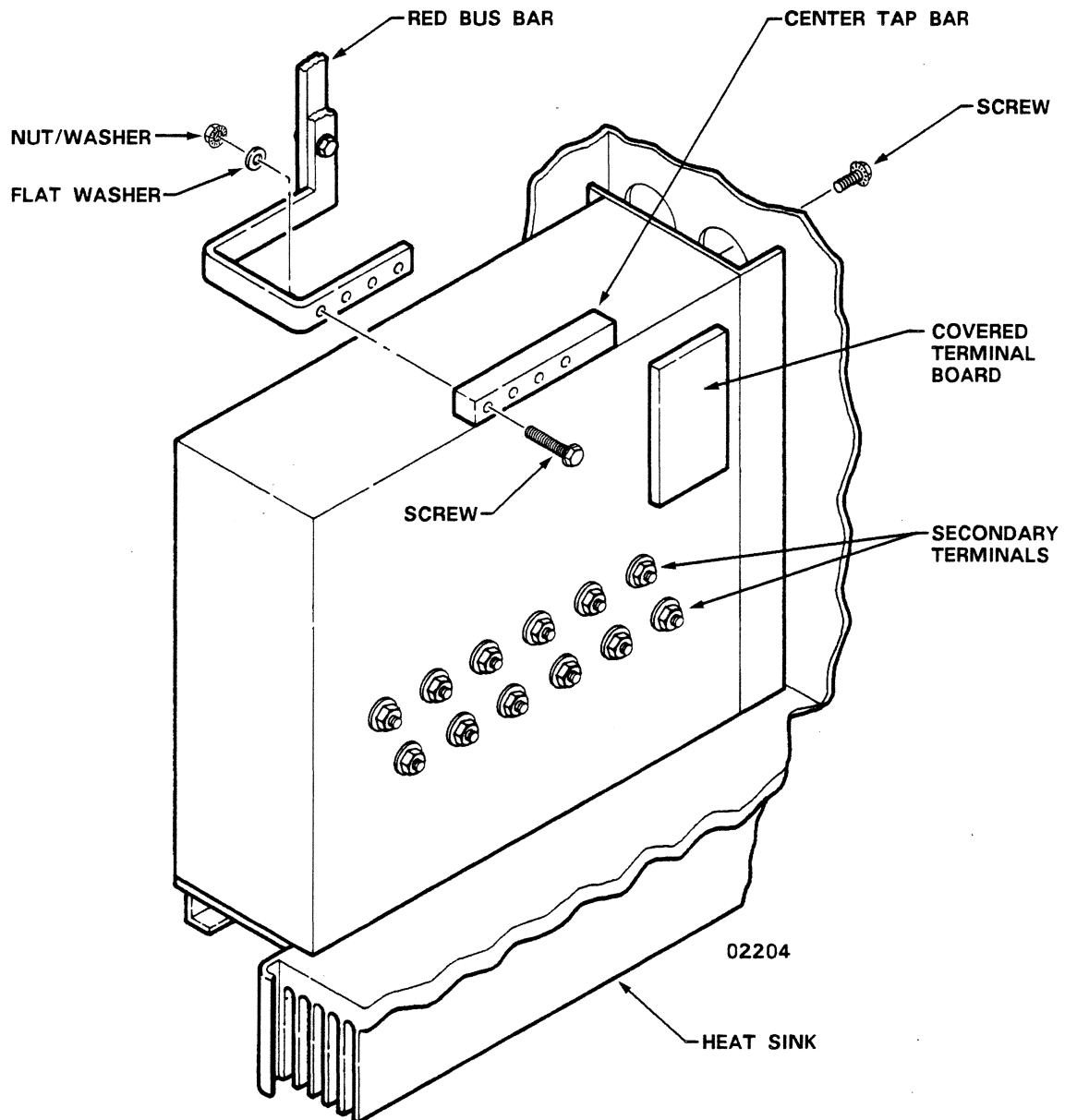


Figure 10-16. 1T2 Transformer

Replacement

Perform steps of removal procedure in reverse order.

NOTE

Ensure that rubber strips are in place beneath and behind the transformer. Lightly coat bus to center tap bar connection and diode lead to transformer side stud connections with electrical joint compound. Torque nuts that connect diode leads to transformer side lugs and nuts that secure bus to center tap bar to 14.6 N·m (130 lbf·in).

Power Supply Diode Removal/Replacement

Use this procedure to remove and/or replace a diode associated with one of the three power supply transformers installed on the cabinet base heat sink. The diodes and their related power supplies are as follows:

CR1 through CR12	-5.2 V, 300-A diodes
CR13 through CR24	+5.0 V, 150-A diodes
CR26 through CR36	-2.2 V, 150-A diodes

Tools/parts required

- Ratchet wrench
- Modified 1-1/8-in deep socket, CDC P/N 12263227
- Modified 1-1/4-in deep socket, CDC P/N 12263442
- Scotch Brite
- Torque wrench 113 N·m (1000 lbf·in), CDC P/N 12205640
- Thermal grease (GE41), CDC P/N 94657900

Removal

- ___ 1. Remove power from cabinet containing diode to be replaced according to IOU Power Removal/Application.
- ___ 2. Disconnect and remove parts, such as power buses, that restrict removal of power diode. Determining which parts must be removed will vary depending on diode to be removed.
- ___ 3. Remove nut and washer connecting diode lead to transformer secondary terminal.
- ___ 4. Unscrew diode from heat sink with ratchet wrench and appropriate deep socket: CR1 through CR12 use 1-1/4-in socket all others use 1-1/8-in socket.

Replacement

- ___ 1. Clean top surface of heat sink around diode mounting hole with Scotch Brite.
- ___ 2. Apply thermal grease to underside of base and diode threads.
- ___ 3. Screw diode into heat sink assembly.
- ___ 4. Tighten diode using applicable substep:
 - ___ a. Torque diodes CR1 through CR12 to 30.5 N·m (270 lbf·in)
 - ___ b. Torque diodes CR13 through CR36 to 18.8 N·m (165 lbf·in)
- ___ 5. Connect diode lead to transformer side lug with nut and washer and torque nut to 14.6 N·m (130 lbf·in).
- ___ 6. Replace any parts disconnected during removal.
- ___ 7. Apply power to cabinet according to IOU Power Removal/Application.

Power Distribution Box Removal/Replacement

A power distribution box is in the bottom of each IOU cabinet, and is accessed from the front of the cabinet. The power distribution box distributes 400-Hz and 50/60-Hz power to the transformers. In addition to main 400-Hz and 50/60-Hz circuit breakers, the power distribution box also has circuit breakers for the individual dc voltages, as well as autotransformers and a meter which are used to adjust the dc voltages. The power distribution box contains the cabinet fault detection and warning circuits.

Tools/parts required

- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set

Removal

- ___ 1. Set LOC/REM switch to LOC on power distribution box of each IOU chassis present in the system.
- ___ 2. Remove power to mainframe by pressing and releasing POWER OFF switch on power unit.
- ___ 3. Remove power from cabinet containing faulty power distribution box according to IOU Power Removal/Application.
- ___ 4. Unlock power distribution box and swing it out from cabinet front.
- ___ 5. Disconnect 1P1 through 1P5 on lower right side of power distribution box.
- ___ 6. Disconnect 1A4A1P2, 1A4A1P5, and 1A4A1P11 on upper right side of power distribution box.
- ___ 7. Remove ground strap next to hinge.
- ___ 8. Lift box up and away from hinges.
- ___ 9. If this power distribution box is being replaced with a different power distribution box, transfer the written voltage values from NOMINAL VOLTAGE label on this box to NOMINAL VOLTAGE label on replacement box.

Replacement

- ___ 1. Perform steps of removal procedure in reverse order.
- ___ 2. Perform IOU Cabinet Bus Voltage Adjustment procedure.

Power Multiplexer Board Removal/Replacement

The power multiplexer board in each cabinet interfaces that cabinet to the system power unit. The power multiplexer board mounts on the under-side of the blower assembly chamber, and is accessed from the rear of the cabinet.

Tools/parts required

- 3/8-in socket set

Removal

- ___ 1. Set LOC/REM switch to LOC on power distribution box of each IOU chassis present in system.
- ___ 2. Remove power to mainframe by pressing and releasing POWER OFF switch on power unit.
- ___ 3. Remove power from cabinet containing power multiplexer board to be replaced according to IOU Power Removal/Application.
- ___ 4. Label connections to power multiplexer board and unplug each connector.
- ___ 5. Remove four screws and spacers securing power multiplexer board to underside of blower assembly chamber.

Replacement

- ___ 1. Set switches on replacement board to the same positions as those on board being replaced.
- ___ 2. Perform steps of removal procedure in reverse order.

Power Distribution Box Circuit Breaker Removal/Replacement

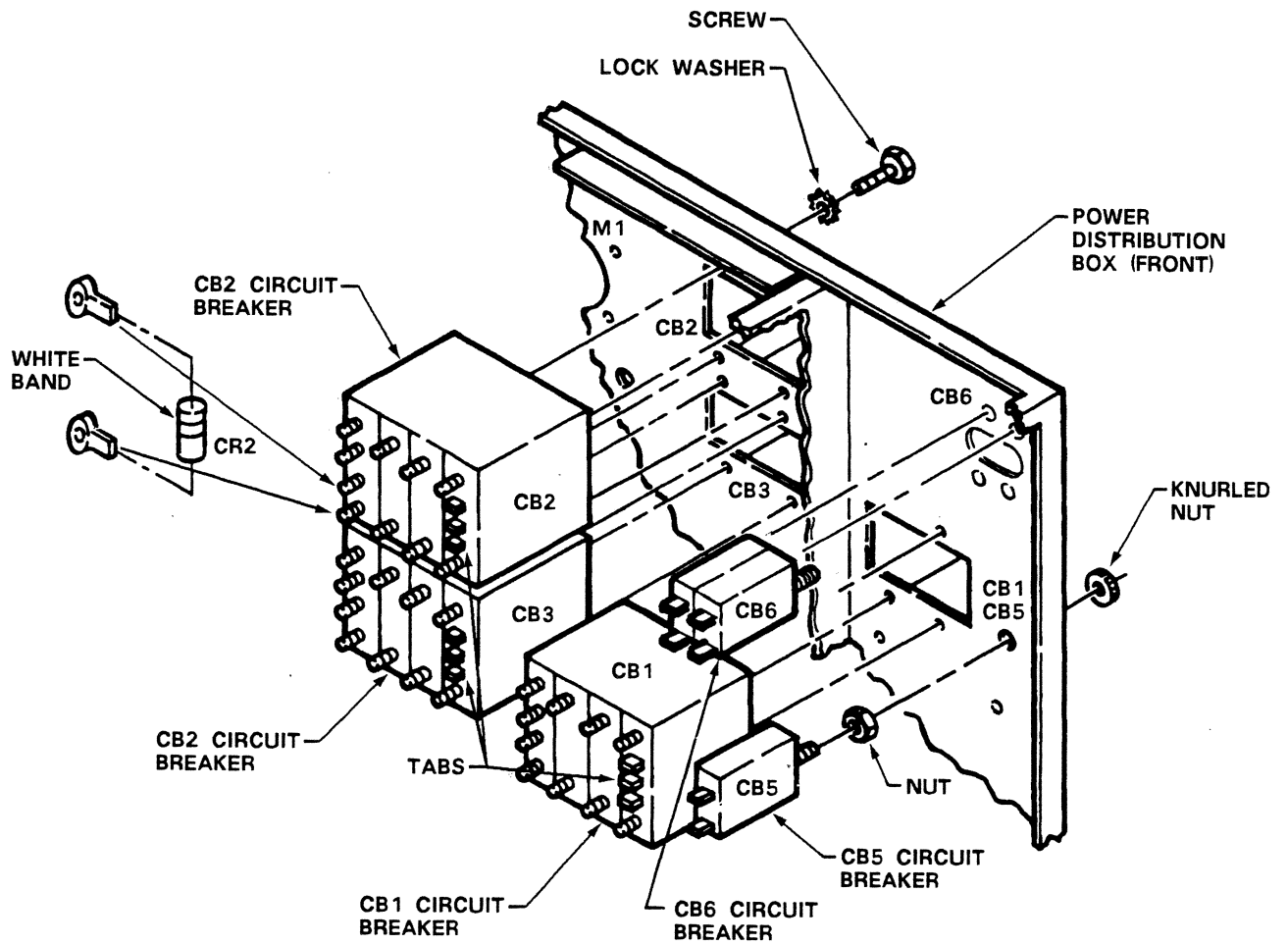
The power distribution box contains six circuit breakers: 50/60 Hz DISCONNECT, 400 Hz MAIN DISCONNECT, V1 (-2.2 V) DISCONNECT, V2 (-5.2 V) DISCONNECT, V3 (+5.5 V) DISCONNECT, and PUSH TO RESET for control circuit. Use this procedure to remove/replace any of the circuit breakers.

Tools/parts required

- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set
- Torque wrench 16.5 N·m (150 lbf·in), CDC P/N 12210926

Removal

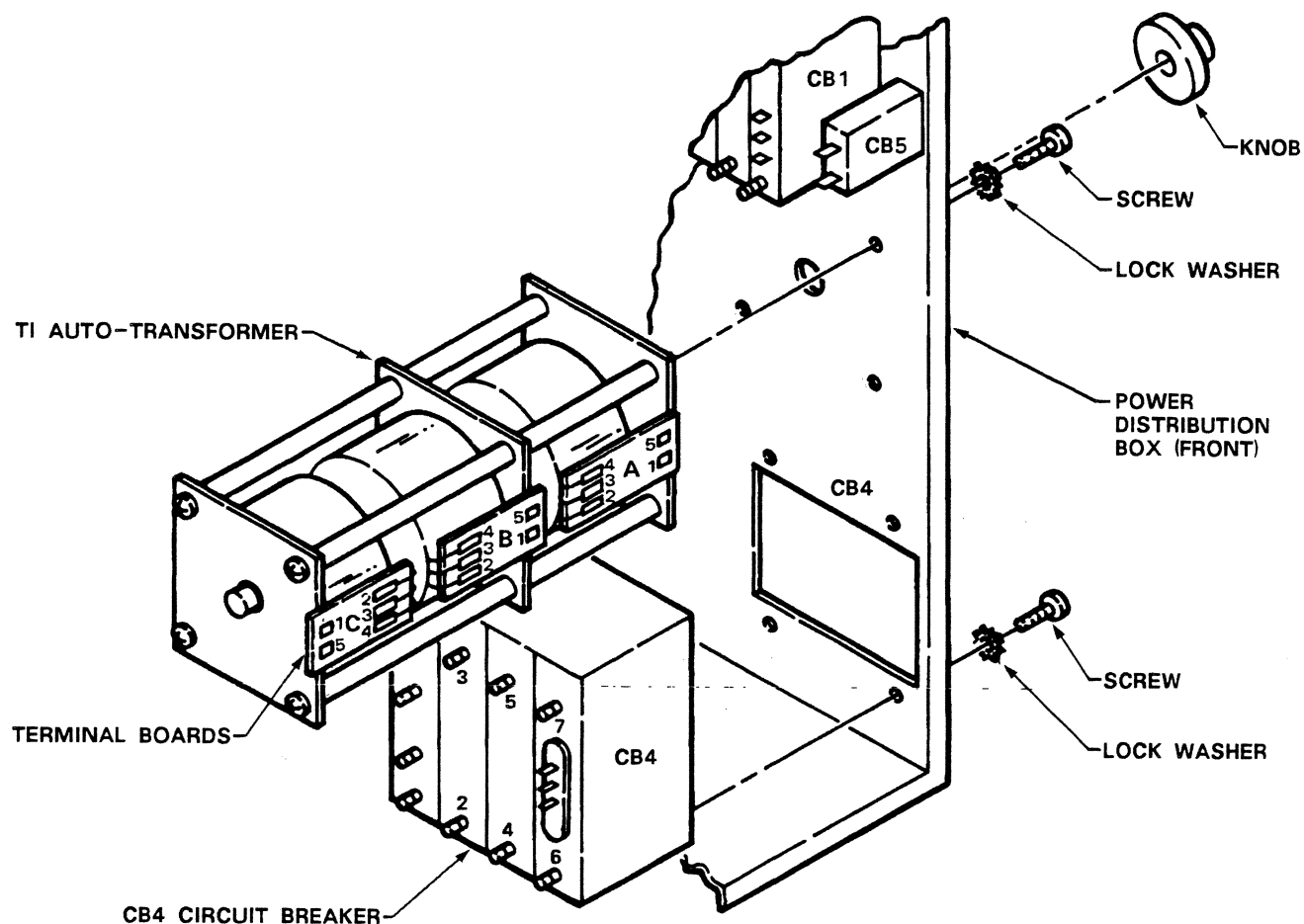
- ___ 1. Remove power from cabinet containing circuit breaker to be replaced according to IOU Power Removal/Application.
- ___ 2. Remove screws holding left-side metal screen to power distribution box. Remove screen.
- ___ 3. Label wires, then remove from terminals of faulty circuit breaker.
- ___ 4. Remove screws (knurled nut on CB5) holding faulty circuit breaker to power distribution box front panel (figures 10-17 and 10-18). Remove circuit breaker.



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Figure 10-17. CB1, CB2, CB3, CB5, and CB6 Circuit-Breaker Installation

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Figure 10-18. CB4 Circuit-Breaker Installation

Replacement

- ___ 1. Perform steps of removal procedure in reverse order with the following exceptions:
 - ___ a. CB1 - Torque nuts to 1.15 N·m (10 lbf·in).
 - ___ b. CB2 - Attach diode leads to terminals 1b and 2b with white-striped end of diode connected to 1b.
 - ___ c. CB4 - Torque nuts to 1.92 N·m (17 lbf·in).

Power Distribution Box Autotransformer Removal/Replacement

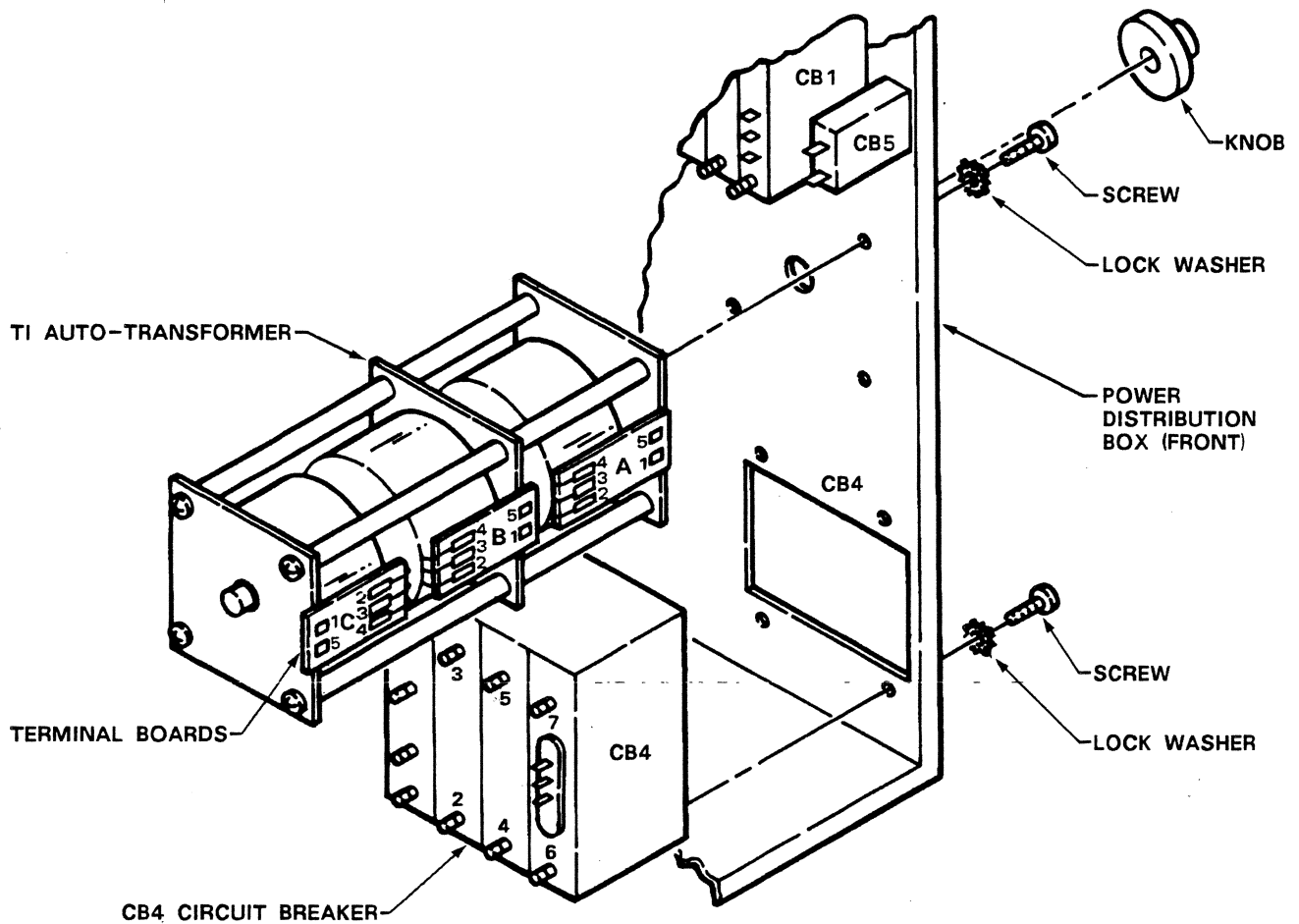
The power distribution box contains three autotransformers. Use this procedure to remove and replace any of the autotransformers.

Tools/parts required

- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set
- Allen wrench assortment
- Torque wrench 16.5 N·m (150 lbf·in), CDC P/N 12210926

Removal

- ___ 1. Remove power from cabinet containing autotransformer to be replaced according to IOU Power Removal/Application.
- ___ 2. Remove power distribution box according to Power Distribution Box Removal/Replacement.
- ___ 3. Remove any parts that restrict removal of autotransformer:
 - A4T1 – Remove left-side wire screen and connector side panel.
 - A4T2/3 – Remove power warning board according to Power Distribution Box Power Warning Board Removal/Replacement.
- ___ 4. Remove power distribution box back.
- ___ 5. Identify and remove all wires on faulty autotransformer.
- ___ 6. Loosen Allen screw securing knob to autotransformer shaft. Remove knob.
- ___ 7. Hold autotransformer in place while unfastening and removing the screws and lock washers securing autotransformer. Remove autotransformer (figures 10-19 and 10-20).



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Figure 10-19. T1 Autotransformer

Replacement

- ___ 1. Perform steps of removal procedure in reverse order with following exceptions:
 - ___ a. T1 - Torque screws on wire terminals to 0.79 N·m (7.00 lbf·in).
 - ___ b. T2/T3 - Torque screws on wire terminals to 1.92 N·m (17.00 lbf·in).
- ___ 2. Perform IOU Cabinet Bus Voltage Adjustment procedure.

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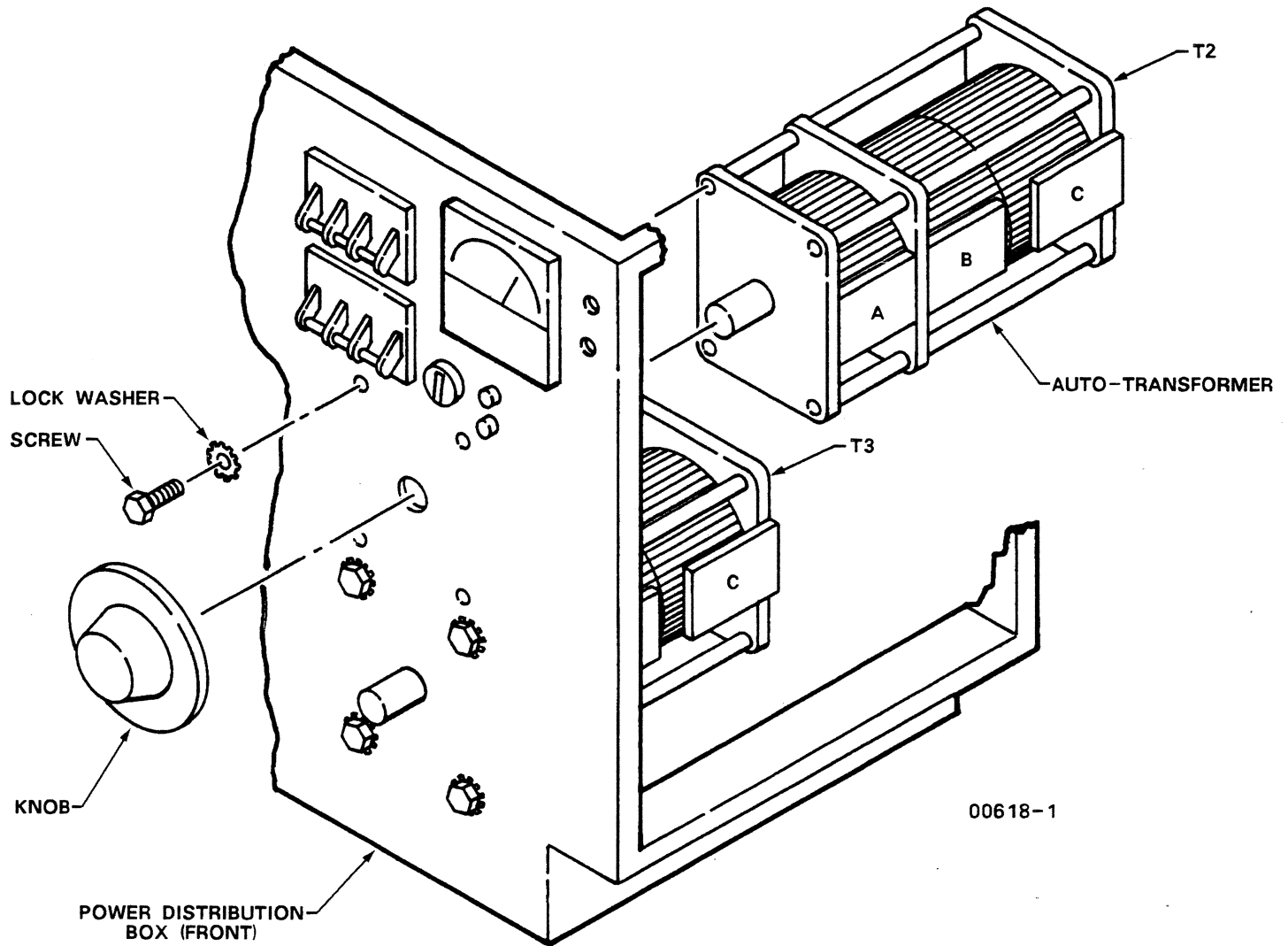


Figure 10-20. T2 and T3 Autotransformer

Power Distribution Box Transformer Removal/Replacement

Transformer A4T4 is on the floor of the power distribution box. Transformer A4T5 is suspended from a plate across the top center of the power distribution box. Separate procedures are provided for each transformer.

Tools/parts required

- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set
- Soldering iron
- Torque wrench 16.5 N·m (150 lbf·in), CDC P/N 12210926

A4T4 Transformer removal

- ___ 1. Remove power to the cabinet containing the faulty transformer according to IOU Power Removal/Application.
- ___ 2. Unfasten screws and remove left-side wire screen from power distribution box.
- ___ 3. Label wires and unsolder them from transformer terminals.
- ___ 4. Unfasten and remove screws, lock washers, and nuts holding transformer.
- ___ 5. Remove transformer.

A4T4 Transformer replacement

Perform steps of removal procedure in reverse order.

A4T5 Transformer removal

- ___ 1. Remove power to cabinet containing the faulty transformer according to IOU Power Removal/Application.
- ___ 2. Unfasten screws and remove top and back screen of power distribution box.
- ___ 3. Unscrew and remove phenolic cover from terminal board.
- ___ 4. Label wires and disconnect them from terminal board.
- ___ 5. While supporting transformer from below, remove bolts securing transformer mounting plate to angle brackets (figure 10-21).
- ___ 6. Remove transformer and mounting plate through top of power distribution box.
- ___ 7. Remove plate from transformer.

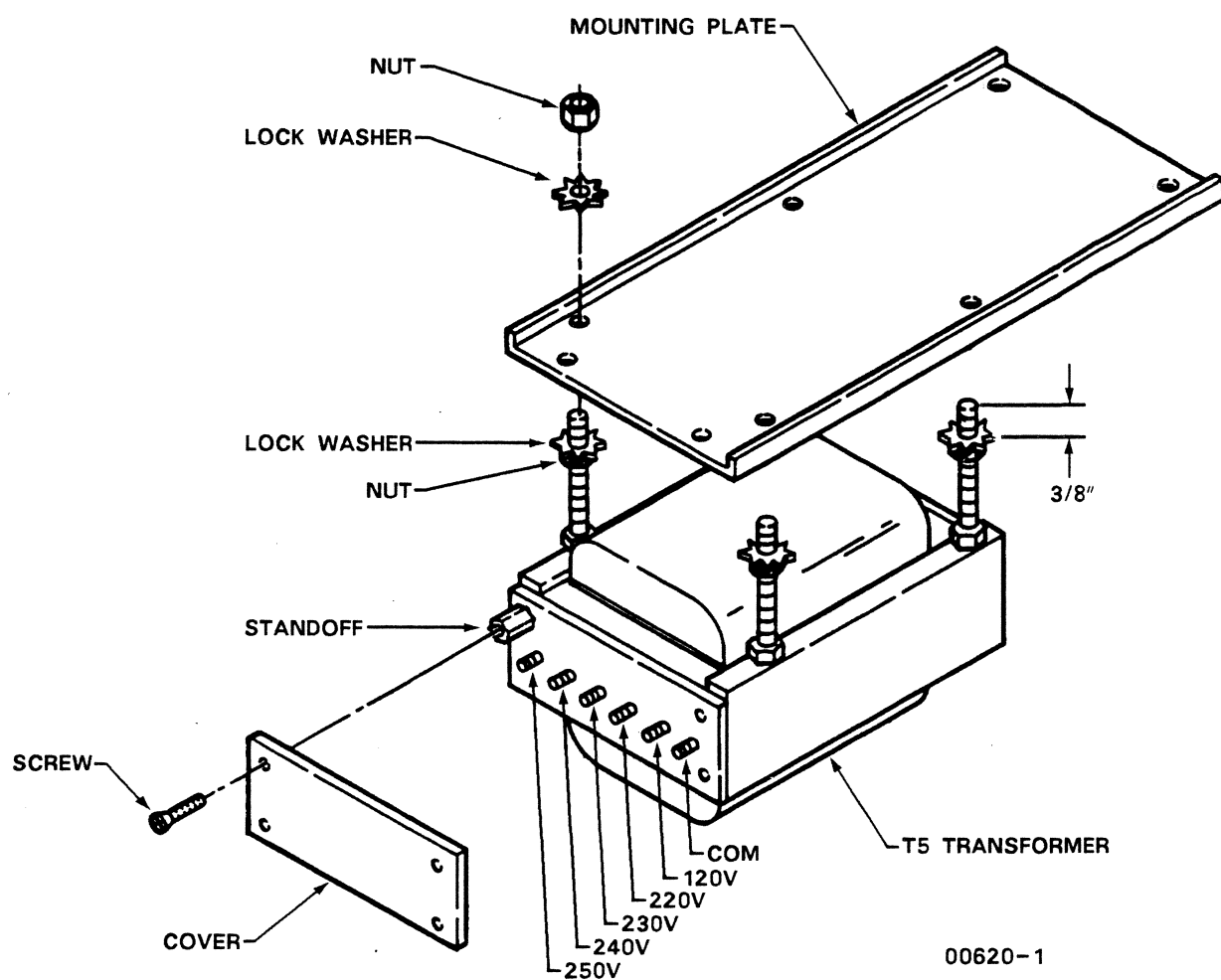
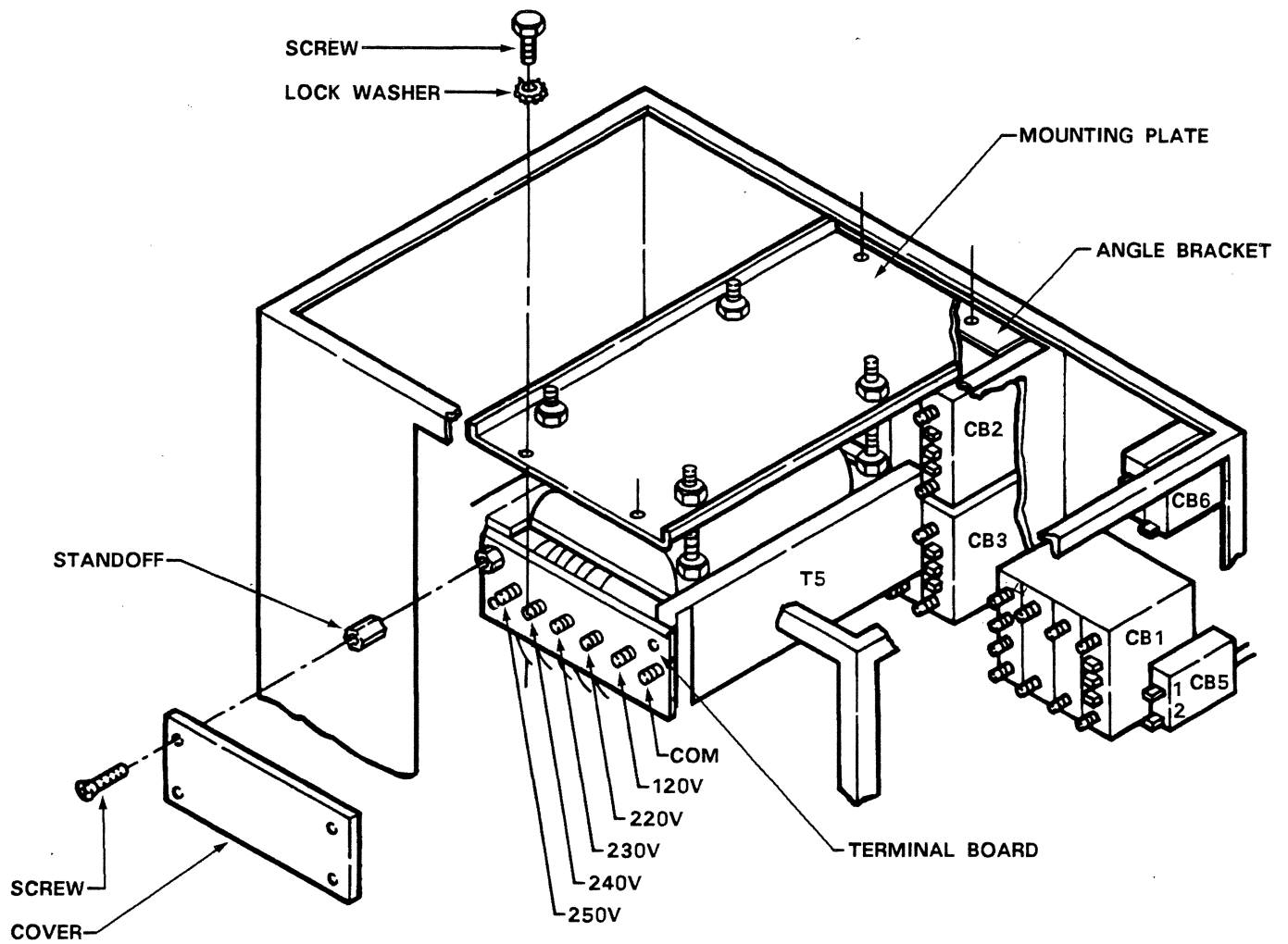


Figure 10-21. T5 Transformer

A4T5 Transformer replacement

- ___ 1. Thread a hex nut on each transformer stud until 3/8-in exists between nut and end of stud. Add one lock washer to each stud.
- ___ 2. Position mounting plate over transformer studs. Align mounting plate over angle brackets and fasten with screws.
- ___ 3. Orient transformer and mounting plate. Align mounting plate over angle brackets and fasten with screws (figure 10-22).
- ___ 4. Remove phenolic cover from terminal board, attach wires to transformer terminal board, and torque connections to 1.15 N•m (10 lbf•in).
- ___ 5. Attach transformer terminal board phenolic cover with nuts.
- ___ 6. Attach top plate and back screen to power distribution box.
- ___ 7. Replace power distribution box according to Power Distribution Box Removal/Replacement.



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Figure 10-22. Transformer Installation

Power Distribution Box Meter Removal/Replacement

The meter and its multiplier board are installed on the power distribution box front panel.

Tools/parts required

- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set

Removal

- ___ 1. Remove power to cabinet containing faulty meter according to IOU Power Removal/Application.
- ___ 2. Remove nuts securing multiplier board to meter (figure 10-23). Set board aside.
- ___ 3. Remove nuts securing meter to panel. Remove meter.

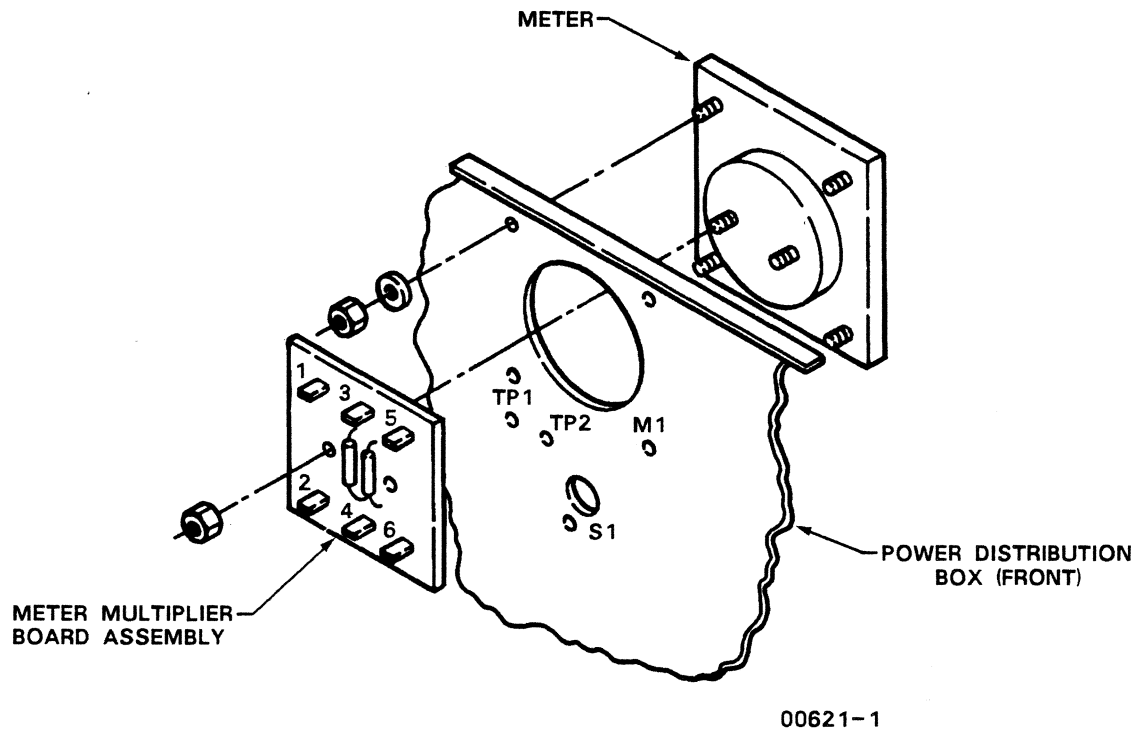


Figure 10-23. Meter Installation

Replacement

- ___ 1. Perform steps of removal procedure in reverse order.
- ___ 2. Perform IOU Cabinet Bus Voltage Adjustment procedure.

Power Distribution Box Relay Removal/Replacement

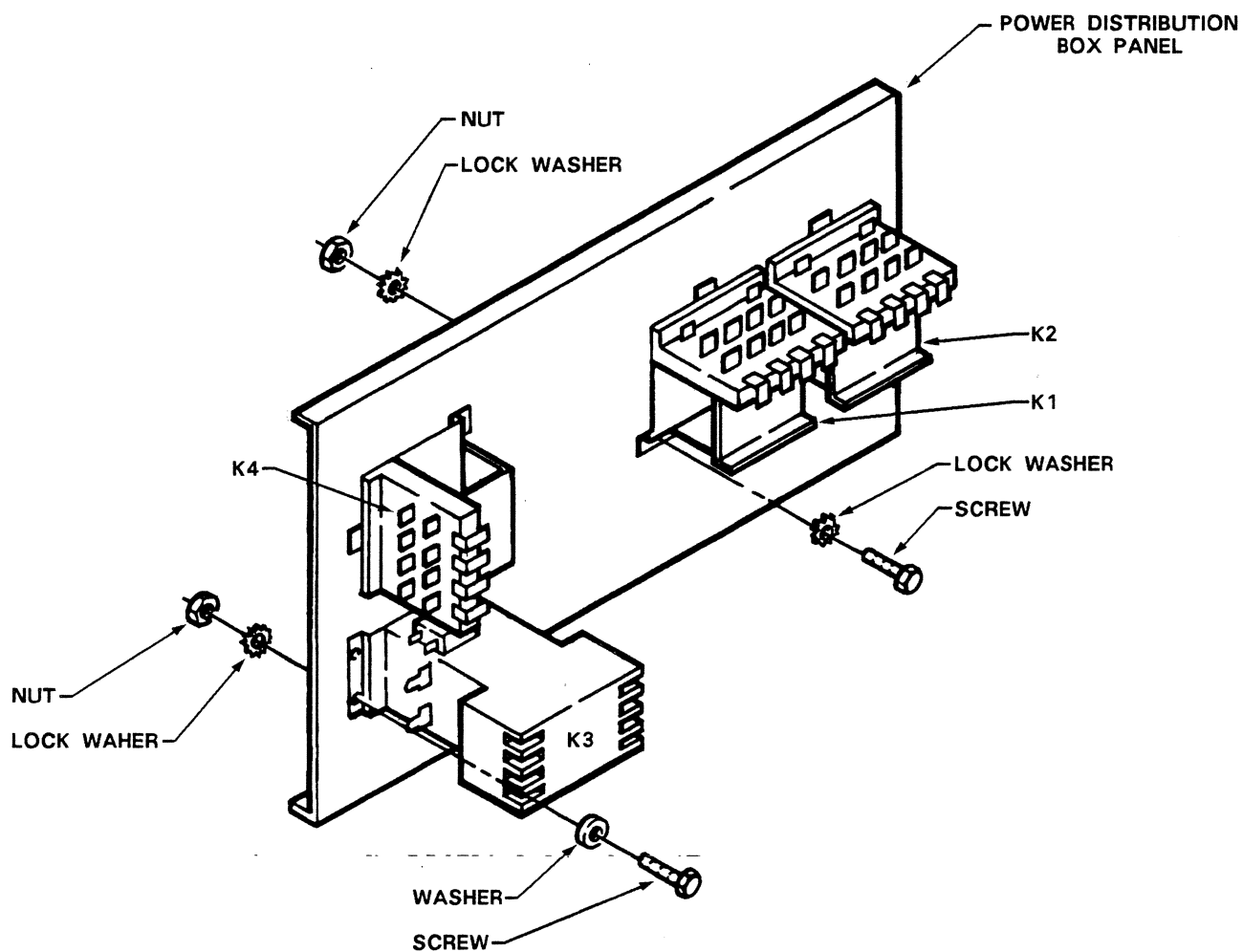
Relays A4K1, A4K2, A4K3, and A4K4 mount on a panel within the power distribution box.

Tools/parts required

- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set
- Torque wrench 16.5 N·m (150 lbf·in), CDC P/N 12210926

Removal

- ___ 1. Remove power to the cabinet containing the faulty relay according to IOU Power Removal/Application.
- ___ 2. Unfasten screws and remove power distribution box top and left-side metal screen. If replacing either A4K3 or A4K4, unfasten screws and remove power distribution box back.
- ___ 3. Unfasten screws and remove sheet metal top and left-side wire screen.
- ___ 4. Remove screws securing T5 and mounting plate to angle bracket. Slide T5 aside.
- ___ 5. Label wires and remove them from terminals of faulty relay.
- ___ 6. Unfasten and remove screws, lock washers, and nuts securing relay (figure 10-24). Remove relay.



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Figure 10-24. Relay Installation

Replacement

- ___ 1. Perform steps of removal procedure in reverse order with following exceptions:
 - ___ a. K1, K2, and K4 - Torque nuts to 1.92 N·m (17.00 lbf·in).
 - ___ b. K3 - Torque nuts to 1.7 N·m (15.0 lbf·in).

Power Distribution Box Rectifier Removal/Replacement

Use this procedure to remove/replace rectifier A4CR1 located on the left-side, bottom rear of the power distribution box interior.

Tools/parts required

- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set

Removal

- ___ 1. Remove power to the cabinet containing the faulty rectifier according to IOU Power Removal/Application.
- ___ 2. Unfasten and remove power distribution box left-side end screen.
- ___ 3. Label wires on A4CR1 according to plus and minus connections and disconnect each.
- ___ 4. Remove screws securing A4CR1 to floor of power distribution box and remove rectifier.

Replacement

Perform steps of removal procedure in reverse order.

Power Distribution Box Rotary Switch Removal/Replacement

Use this procedure to remove/replace rotary switches A4S1 and A4S2 mounted on the front panel of the power distribution box.

Tools/parts required

- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set
- Allen wrench set

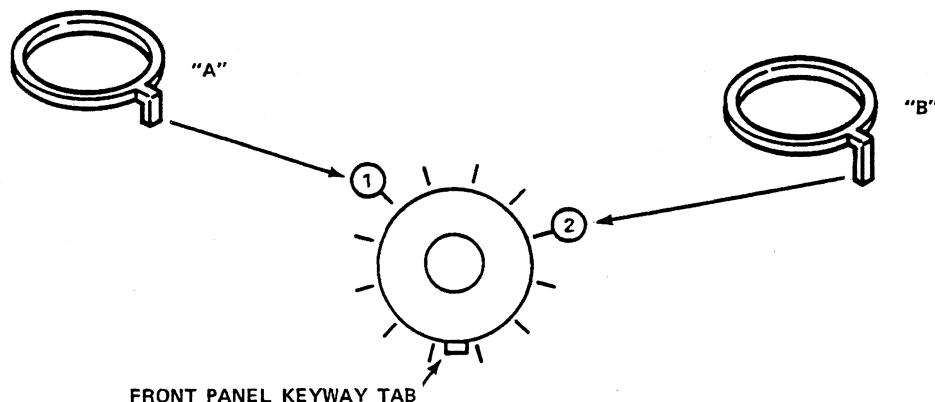
Removal

- ___ 1. Remove power to the cabinet containing the faulty rectifier according to IOU Power Removal/Application.
- ___ 2. Remove power distribution box from cabinet according to Power Distribution Box Removal/Replacement.
- ___ 3. Unfasten screws and remove power distribution box top.
- ___ 4. Label wires and disconnect them from faulty rotary switch.
- ___ 5. Loosen Allen-head setscrew and remove rotary switch knob from shaft.
- ___ 6. Unfasten and remove hex nut and washer from rotary switch shaft.
- ___ 7. Remove faulty switch.

Replacement

- ___ 1. Remove nut and lock washer from switch front shaft.

- ___ 2. Reposition rings as follows (figure 10-25).
 - ___ a. Position ring A (supplied) so that tab locks into location 1.
 - ___ b. Adjust front shaft of switch to counterclockwise stop.
 - ___ c. Position ring B (supplied) so that tab locks into location 2.



S1-FRONT VIEW

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Figure 10-25. A4S1 Switch Orientation and Mechanical Stops

- ___ 3. Orient switch with keyway tab down and insert switch into mounting hole.
- ___ 4. Fasten switch with hex nut and washer.
- ___ 5. Attach labeled wires to switch terminals.
- ___ 6. Replace power distribution box top.
- ___ 7. Replace rotary switch knob.
- ___ 8. Replace power distribution box in cabinet according to Power Distribution Box Removal/Replacement.

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Power Distribution Box Power Warning Board Removal/Replacement

The power warning board contains the components and circuits for power-on and power-off sequencing and the indicators for faults and warnings. The board assembly mounts inside the power distribution box.

Tools/parts required

- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set

Removal

- ___ 1. Remove power to the cabinet containing the faulty power warning board according to IOU Power Removal/Application.
- ___ 2. Unfasten screws and remove power distribution box top.
- ___ 3. From inside power distribution box, disconnect and remove plugs from connectors J3 and J4 on logic module (figure 10-26).
- ___ 4. From outside power distribution box on right side, disconnect and remove plugs from logic module connectors 1P11 and 1P2, pulling plugs and wiring through opening in side of power distribution box.
- ___ 5. Remove logic module by pulling straight up so that board does not jam in card guides.

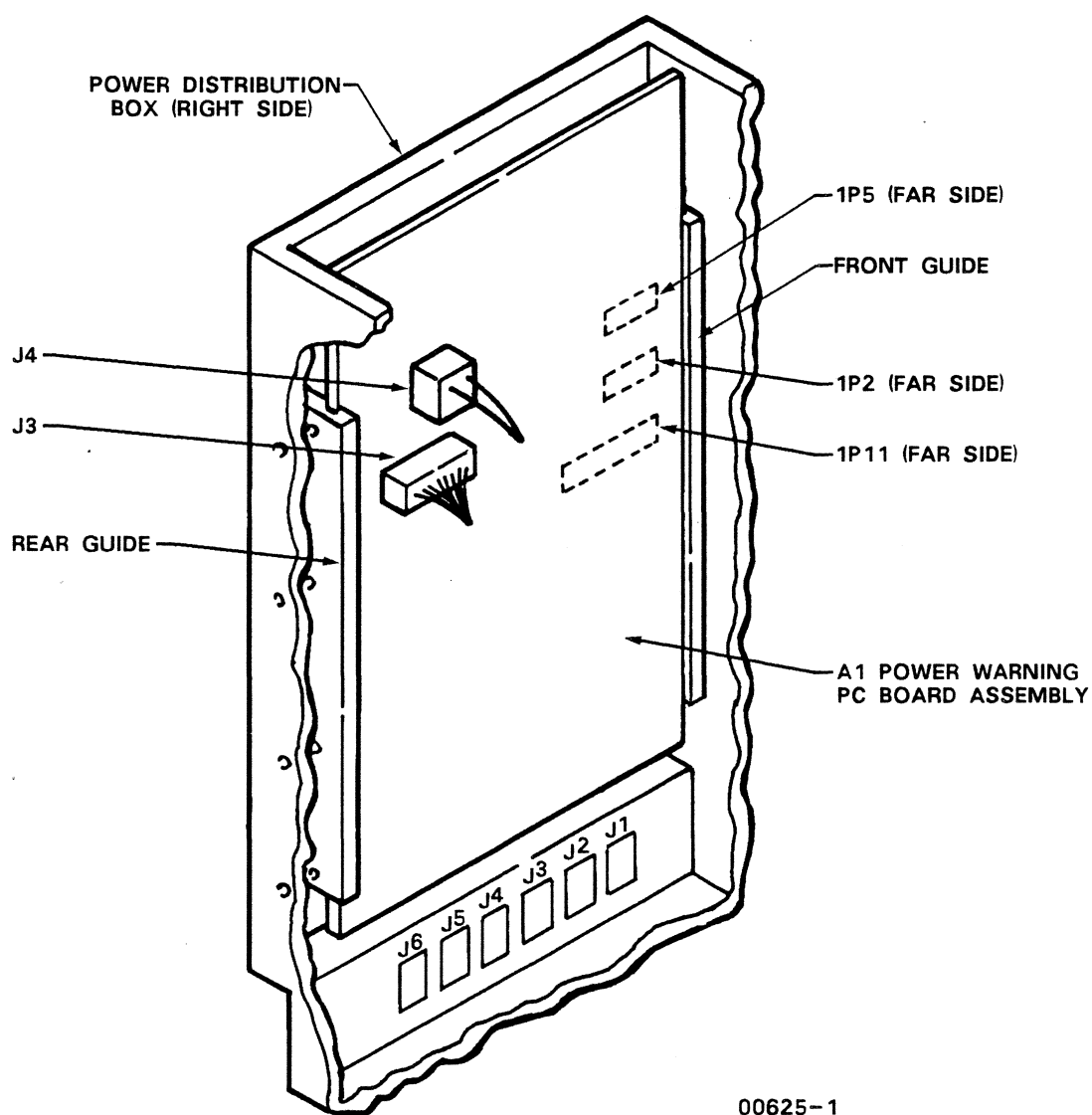


Figure 10-26. Power-Warning Logic Module Installation

Replacement

Perform steps of removal procedure in reverse order.

Thermostat Removal/Replacement

Use this procedure to remove/replace the thermostats 1S1 or 1S2 located on the top of the power heat sink to either side of transformer 1T3.

Tools/parts required

- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set
- Soldering iron
- Brillo pad
- Thermal grease (GE641), CDC P/N 94657900

Removal

- ___ 1. Remove power to the cabinet containing the faulty thermostat according to IOU Power Removal/Application.
- ___ 2. Unsolder and remove two wires from faulty thermostat terminals (figure 10-27).
- ___ 3. Remove screws and washers securing thermostat to heat sink and set faulty device aside.

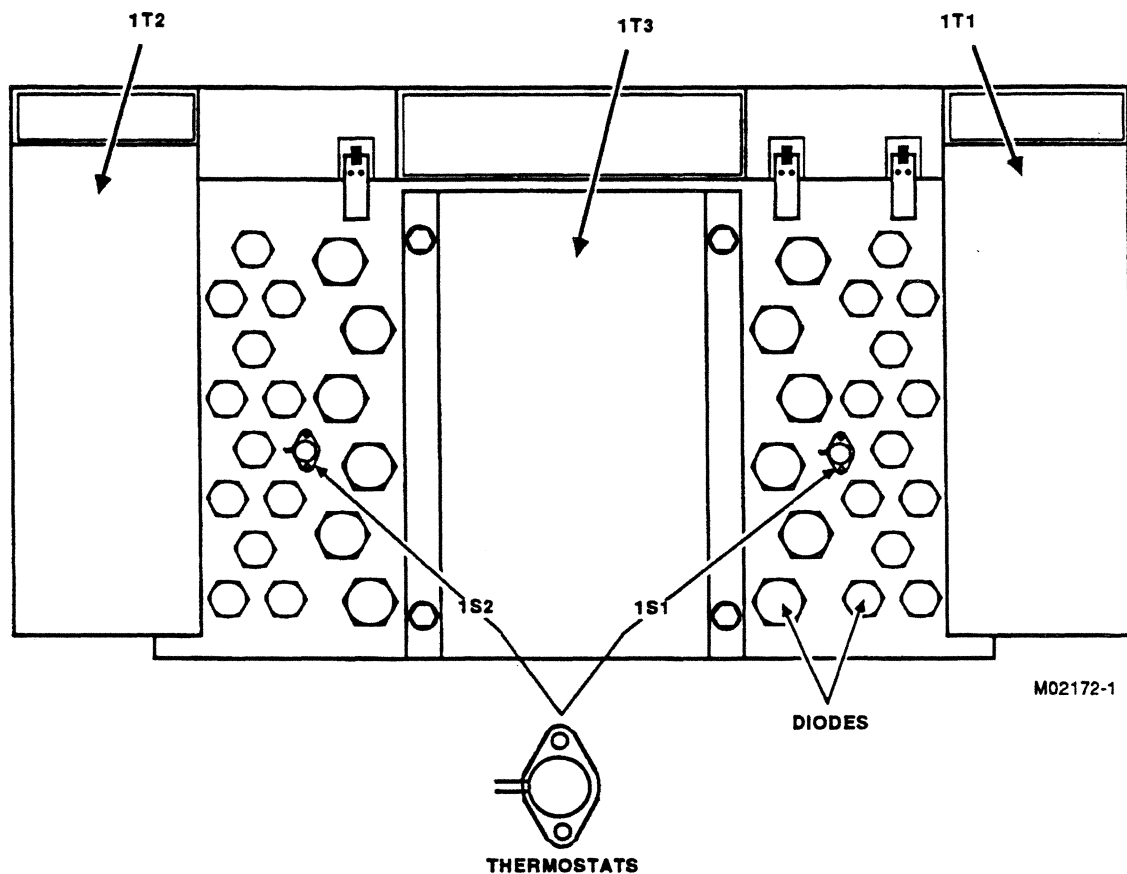


Figure 10-27. 1S1 and 1S2 Thermostats

Replacement

- ___ 1. Clean underside of thermostat and heat sink contact area with Brillo pad.
- ___ 2. Apply thermal grease to underside of thermostat.
- ___ 3. Fasten thermostat to heat sink with screws and washers.
- ___ 4. Solder wires to thermostat terminals and slide sleeving over terminals.

Temperature Sensor Removal/Replacement

Use this procedure to remove/replace the temperature sensors 1TS1, 1TS2, 1TS3, or 1TS4. Sensors 1TS1, 1TS2, and 1TS3 are located on the top of the power heat sink to either side of transformer 1T3. Sensor 1TS4 is located at the top right-hand corner of the power distribution box.

Tools/parts required

- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set

Removal

- ___ 1. Remove power to the cabinet containing the faulty temperature sensor according to IOU Power Removal/Application.
- ___ 2. Perform either step 3 to remove 1TS1, 1TS2, or 1TS3, or step 4 to remove 1TS4.
- ___ 3. The three temperature sensors are accessible from the rear of the cabinet, and can be removed by performing substeps a and b (figure 10-28).
 - ___ a. Remove screws securing temperature sensor spacer and temperature sensor to heat sink.
 - ___ b. Pull assembly clear of chassis and disconnect cable plug from temperature sensor.
- ___ 4. Temperature sensor 1TS4 is accessible from the front of the cabinet, and can be removed by performing substeps a through c (figure 10-29).
 - ___ a. Slide sensor protect cover clear of temperature sensor (engages standoffs).
 - ___ b. Remove two screws and washers securing temperature sensor to standoffs.
 - ___ c. Pull assembly clear of chassis and disconnect cable plug from temperature sensor.

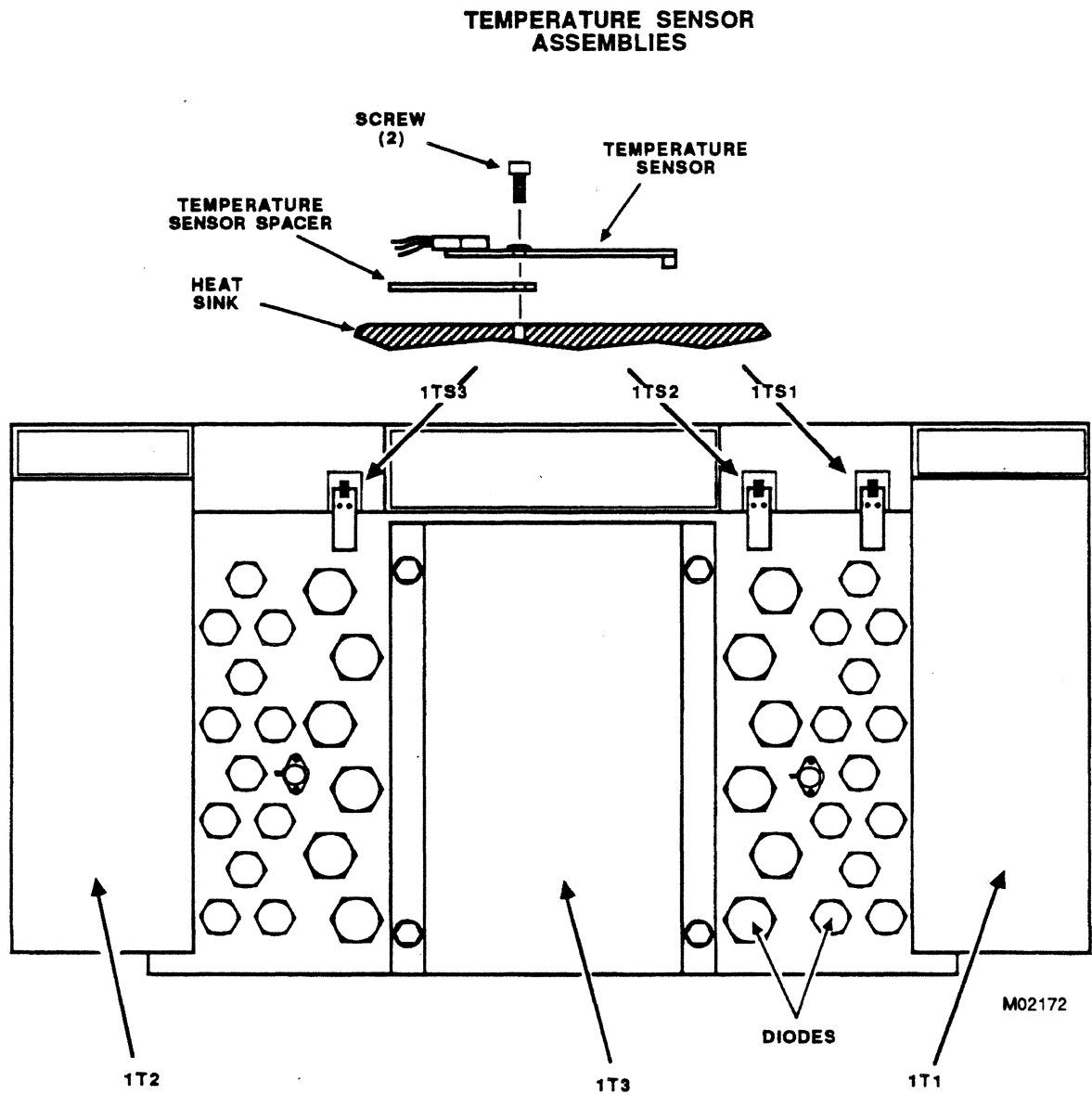


Figure 10-28. 1TS1, 1TS2, and 1TS3 Temperature Sensors

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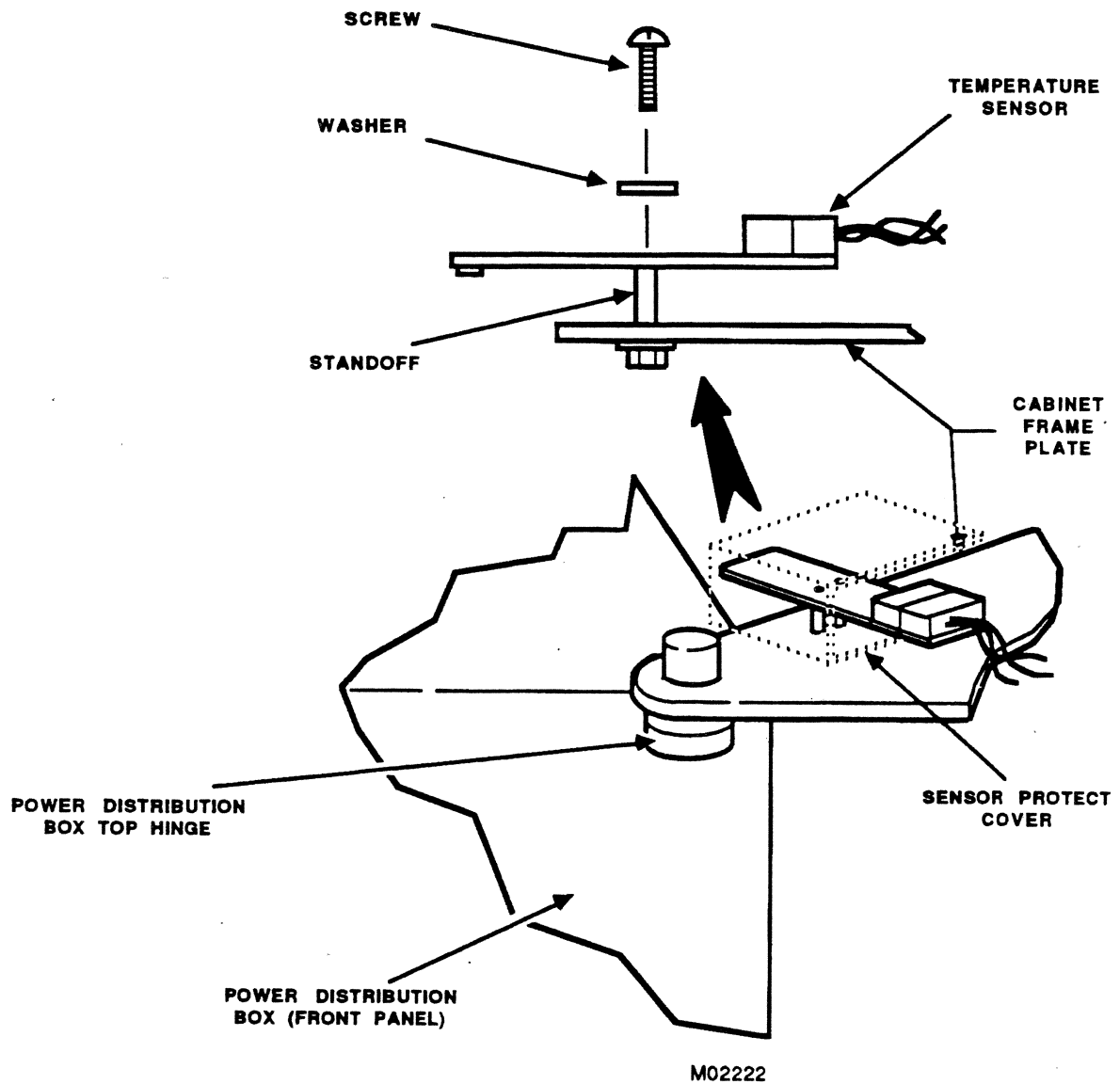


Figure 10-29. 1TS4 Temperature Sensor

Replacement

Perform steps of removal procedure in reverse order.

NOTE

Ensure that temperature sensor tip on 1TS1, 1TS2, or 1TS3 is firmly in contact with heat sink at completion of replacement.

Power Supply SCR Removal/Replacement

Three silicon controlled rectifiers (SCRs), 1CR37, 1CR38, and 1CR39 provide transient protection for the circuits from potentially harmful voltage or current overloads. During an overload, the SCRs instantly short their associated power buses to ground while slower reacting contactors remove power from the voltage bus. The SCRs are accessible from the rear of the cabinet and are located just above the large transformers on the cabinet base heat sink.

Tools/parts required

- Flat-blade screwdriver
- Phillips screwdriver
- 3/8-in socket set
- Adjustable wrench
- 1-1/16-in open end wrench
- 1-1/8-in open end wrench
- Scotch Brite
- Thermal grease (GE641), CDC P/N 94657900
- 1-1/8-in socket
- Torque wrench 113 N·m (1000 lbf·in), CDC P/N 12205640

Removal

- ___ 1. Remove power from cabinet containing faulty SCR according to IOU Power Removal/Application.
- ___ 2. Label, unscrew, and remove small red and white wires from faulty SCR at 1TB1 or 1TB2, as applicable, on ground grid plate.
- ___ 3. Loosen and remove bolt, washers, and nut (if used) securing SCR flexible power lead to transformer center tap bar or ground grid plate (1CR37), as applicable.
- ___ 4. Loosen and remove locking nut from SCR stud bolt with 1-1/16-in open end wrench. Use adjustable wrench on SCR body to prevent it from turning.
- ___ 5. Remove mounting nut from SCR stud bolt using 1-1/8-in open end wrench.
- ___ 6. Remove SCR.

Replacement

- ___ 1. Clean contact surface on ground grid plate or red bus, as applicable, with Scotch Brite.
- ___ 2. Apply thin layer of thermal grease to underside of base and threads of SCR.
- ___ 3. Insert SCR through hole in ground grid plate or red bus, as applicable, and screw mounting nut onto SCR stud bolt by hand.
- ___ 4. Hold SCR body with adjustable wrench while using torque wrench and 1-1/8-in socket to tighten mounting nut as follows:
 - ___ a. 1CR37 to 4.5 N·m (40 lbf·in)
 - ___ b. 1CR38/39 to between 34 and 39 N·m (300 and 360 lbf·in)
- ___ 5. Install locking nut.
- ___ 6. Secure SCR flexible lead as follows:
 - ___ a. Attach 1CR37 flexible power lead to ground grid plate with Torx-head screw, and torque screw to 7.4 N·m (65 lbf·in).
 - ___ b. Attach 1CR38/39 flexible power lead securely to transformer center tap using bolt, washer, and nut.
- ___ 7. Connect SCR's small red and white wires to terminal board 1TB1 or 1TB2, as applicable, on ground grid plate.

Bus Filter Capacitor Removal/Replacement

Use this procedure to replace bus filter capacitors C1 through C20. The capacitors are accessed through the rear of the cabinet.

Tools/parts required

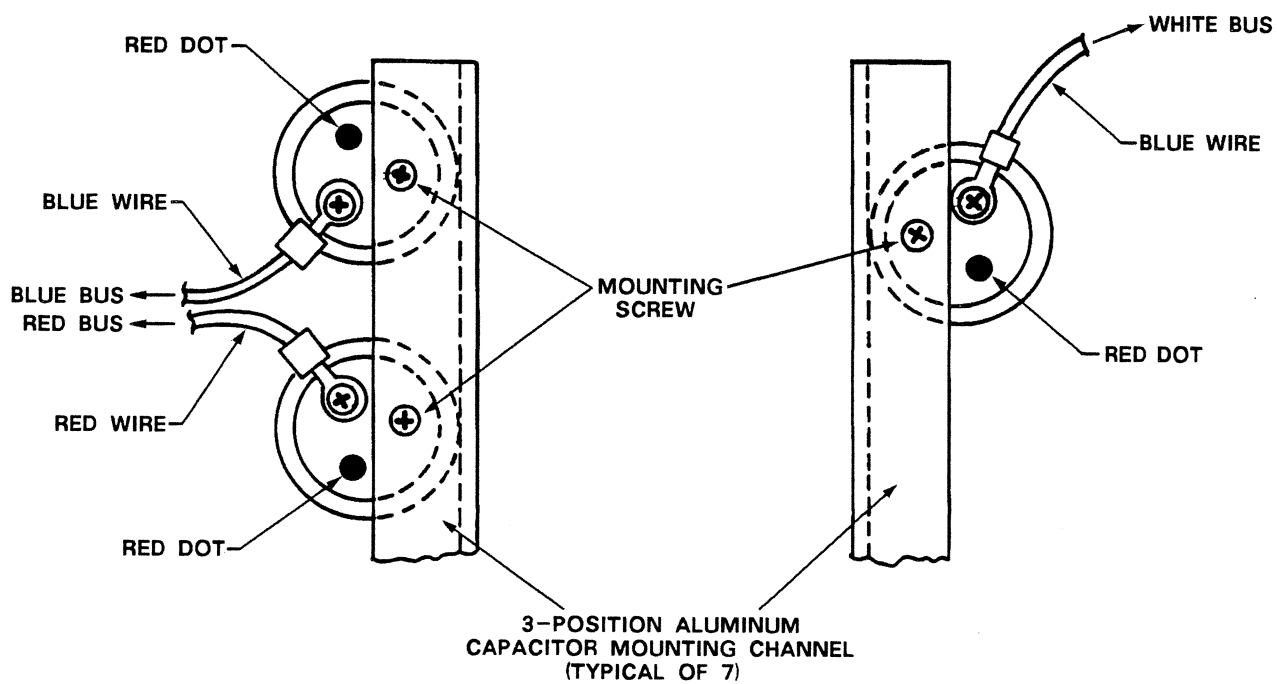
- Phillips screwdriver
- Flat-blade screwdriver
- 3/8-in socket set

Removal

- ___ 1. Remove power from cabinet containing faulty capacitor according to IOU Power Removal/Application.
- ___ 2. Observe polarity of capacitor connection.
- ___ 3. Pull back rubber terminal cover. Unscrew and remove screw and washer that attach capacitor lead to red, white, or blue bus bar (figure 10-30).
- ___ 4. Unscrew and remove screw and washer that attach capacitor to bracket. Remove capacitor.

Replacement

Perform steps of removal procedure in reverse order.



NOTE:

RUBBER TERMINAL COVERS NOT SHOWN.

Figure 10-30. Filter Capacitor Mounting

Two-Port Multiplexer Power Supply Removal/Replacement

NOTE

This procedure does not apply to an AT512-A cabinet.

The two-port multiplexer (TPM) power supply provides power (+5 V, +12 V, and -12 V) for the TPM logic module. The power supply mounts alongside the logic cage in an AT511-A cabinet and is accessed from the front of the cabinet. The supply provides overcurrent and overvoltage protection to the circuits in the TPM.

Tools/parts required

- 3/8-in socket set

Removal

- ___ 1. Remove power from cabinet containing faulty TPM power supply according to IOU Power Removal/Application.
- ___ 2. Disconnect four connectors at top of TPM power supply.
- ___ 3. Remove nuts and washers from studs protruding from underside of shelf supporting TPM power supply.
- ___ 4. Raise TPM power supply until studs clear supporting shelf, and pull assembly clear of chassis.

Replacement

- ___ 1. Perform steps of removal procedure in reverse order.
- ___ 2. Perform IOU Two-Port Multiplexer Power Supply Adjustment procedure.

Power Input Box Filter Removal/Replacement

The power input box of each cabinet contains two power line filters: FL1 for 50/60-Hz, and FL2 for 400-Hz. The power input box is accessed from the front of the cabinet and is located below the IOU cabinet connector panel.

Tools/parts required

- 3/8-in socket set
- Flat-blade screwdriver
- Phillips screwdriver

Removal

- ___ 1. Remove power from the cabinet containing the faulty line filter according to IOU Power Removal/Replacement.
- ___ 2. Remove Torx-head screws securing power input box cover. Set cover aside.
- ___ 3. Disconnect leads to filter as follows:
 - ___ a. FL1 - disconnect Faston connections.
 - ___ b. FL2 - remove screws and washers that connect leads.
- ___ 4. Remove Torx-head screws securing line filter to back of power input box. Remove filter.

Replacement

Perform steps of removal procedure in reverse order.

Cabinet Blower Assembly Removal/Replacement

Use this procedure when replacing the blower assembly in the top of an IOU cabinet.

Tools/parts required

- 3/8-in socket set
- Flat-blade screw driver

Removal

1. Remove power from cabinet containing blower assembly to be replaced according to IOU Power Removal/Application.

⚠ CAUTION

Blower assembly top cover on an IOU cabinet consists of two sections. Part containing grill work must be removed first so that temperature sensor and airflow sensor are not damaged.

2. Remove Torx-head screws from outer edge of blower assembly top cover section that contains grill work (figure 10-31).
3. Raise top cover clear of cabinet and set it aside.
4. Remove Torx-head screws from outer edge of other part of top cover, raise it clear of cabinet, and set it aside.
5. Note blower motor lead wire connection scheme at adjacent terminal strip. Disconnect lead wires at terminal strip.
6. Remove Torx-head screws and nut/washers securing blower assembly to cabinet bulkhead.

Replacement

1. Secure replacement blower assembly to cabinet bulkhead.
2. Connect three blower motor lead wires to adjacent terminal strip.

⚠ CAUTION

Do not contact temperature sensor and/or airflow sensor with blower assembly top cover. Devices may be damaged.

- 3. Place blower assembly top cover that does not contain grill work atop cabinet half containing blower motor. Secure it in place with Torx-head screws.
- 4. Place blower assembly top cover that contains grill work atop other half of cabinet and secure in place with Torx-head screws.

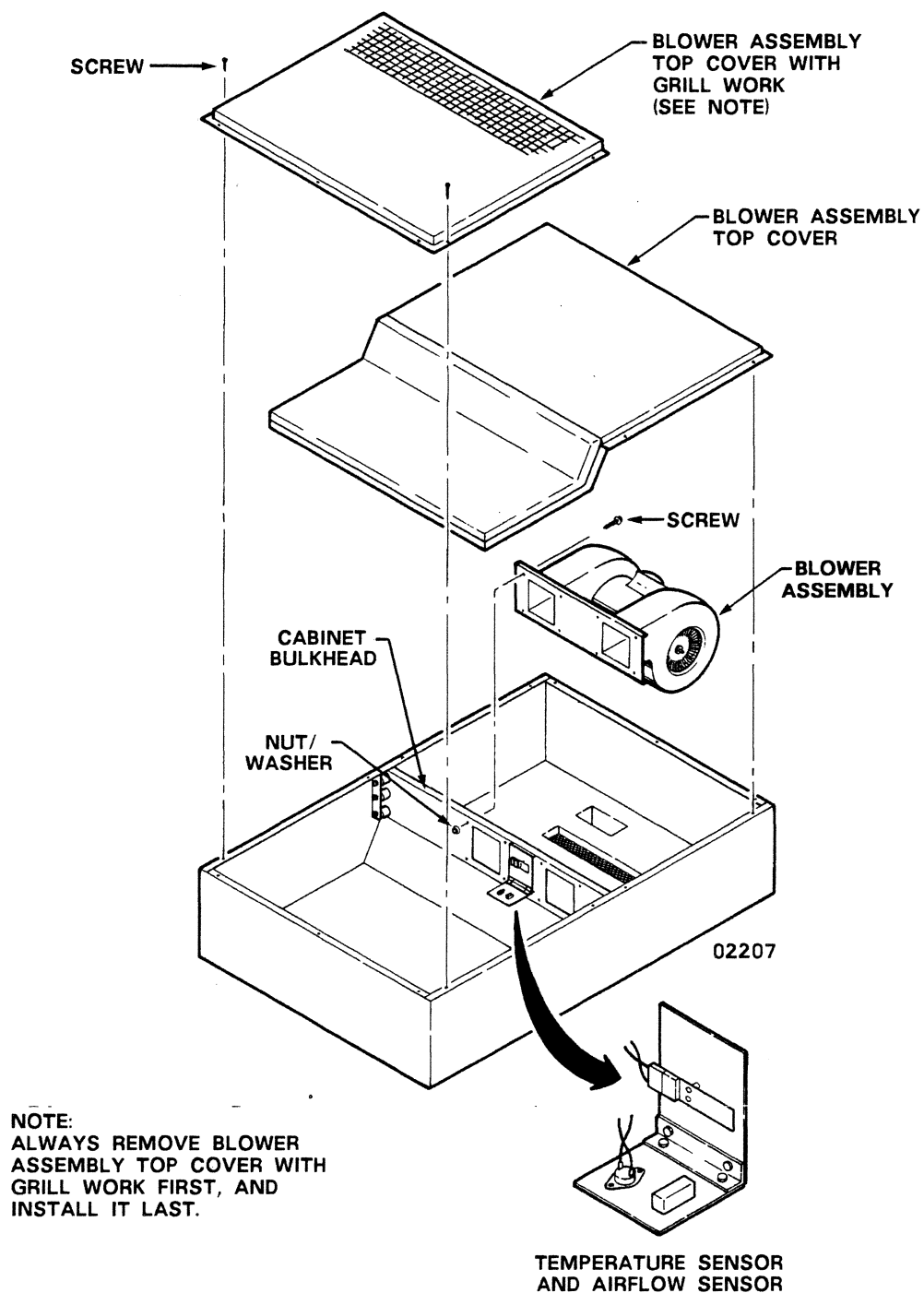


Figure 10-31. Cabinet Blower Assembly

Sensor Assembly Removal/Replacement

Use this procedure to remove/replace the sensor assembly containing the airflow sensor and temperature sensor. The sensor assembly is located in the cabinet blower chamber at the top of the cabinet.

Tools/parts required

- 3/8-in socket set

Removal

1. Remove power to cabinet containing faulty sensor assembly according to IOU Power Removal/Application.

⚠ CAUTION

Blower assembly top cover on an IOU cabinet consists of two sections. Part containing grill work must be removed first so that temperature sensor and airflow sensor are not damaged.

2. Remove Torx-head screws from outer edge of blower assembly top cover section that contains grill work (figure 10-32).
3. Raise top cover clear of cabinet and set it aside.
4. Remove Torx-head screws from outer edge of other part of top cover, raise it clear of cabinet, and set it aside.
5. Disconnect sensor assembly cable plug from mating receptacle.
6. Remove Torx-head screws securing sensor assembly to cabinet bulkhead. Set faulty device aside.

Replacement

1. Secure replacement sensor assembly to cabinet bulkhead with Torx-head screws.
2. Connect sensor assembly cable plug to mating receptacle on cabinet bulkheads.

⚠ CAUTION

Do not contact temperature sensor and/or airflow sensor with blower assembly top cover. Devices may be damaged.

- 3. Place blower assembly top cover that does not contain grill work atop cabinet half containing blower motor. Secure it in place with Torx-head screws.
- 4. Place blower assembly top cover that contains grill work atop other half of cabinet and secure in place with Torx-head screws.

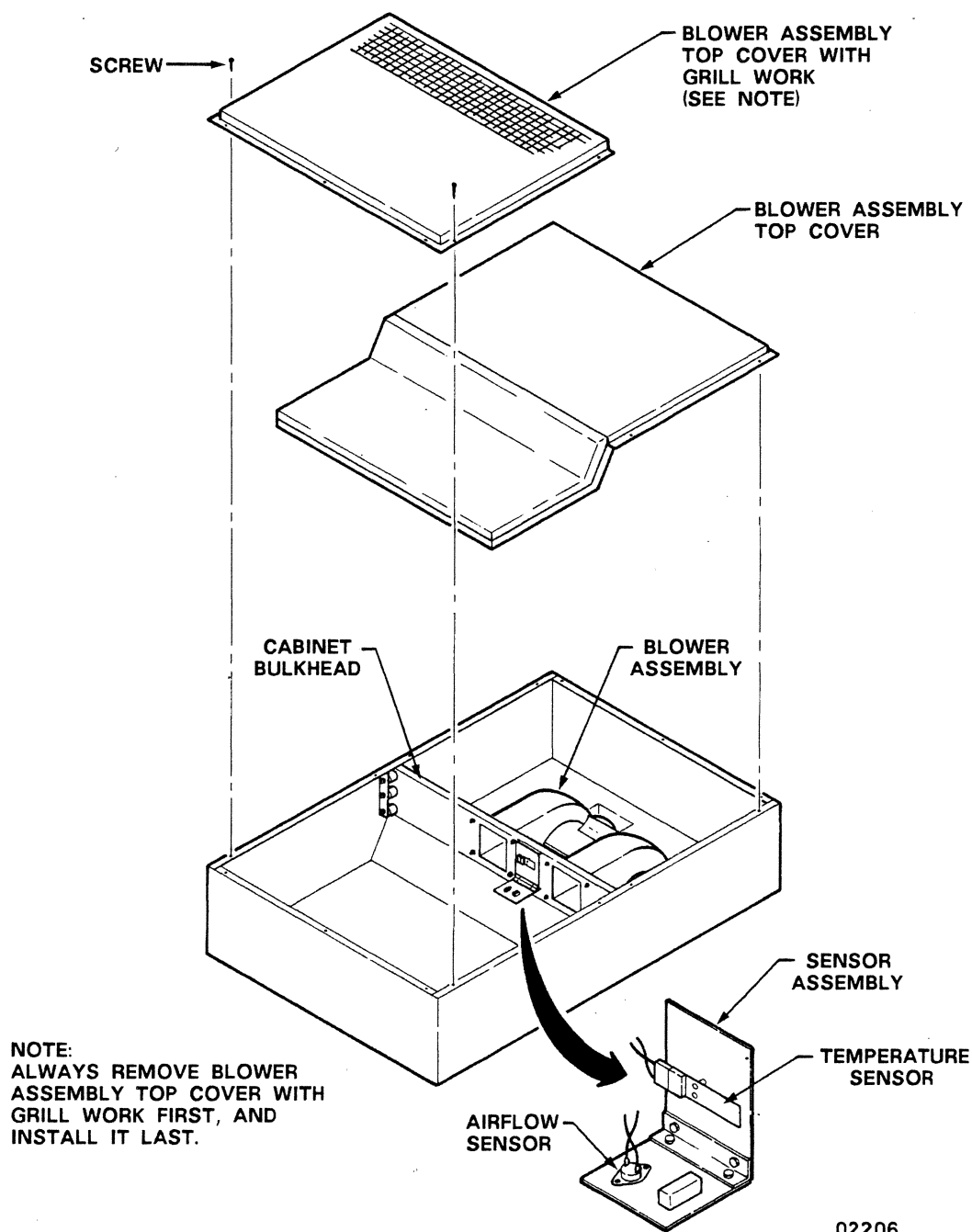


Figure 10-32. Sensor Assembly

IOU Cabinet Bus Voltage Adjustment

Use this procedure to adjust the voltage levels and the metering in a power distribution box of an IOU cabinet. Refer to figure 10-33 while performing this procedure.

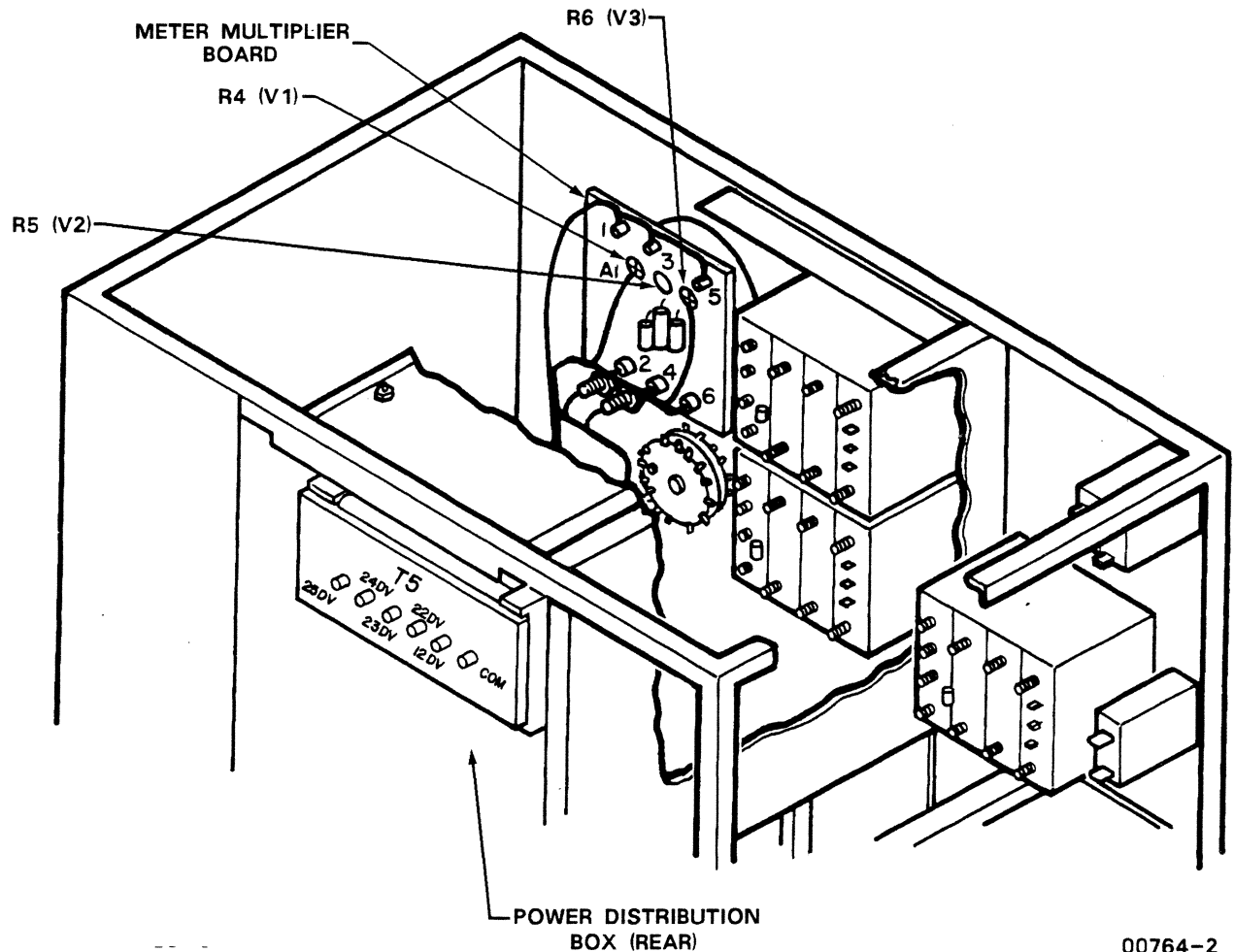
Tools/parts required

- Slotted screwdriver
- Digital multimeter (Fluke 8020A), CDC P/N 12263279

Procedure

- ___ 1. Set site 50/60-Hz wall-mounted circuit breaker for IOU to be adjusted to ON.
- ___ 2. Set site 400-Hz wall-mounted circuit breaker for IOU to be adjusted to OFF.
- ___ 3. Set controls on power distribution box of IOU to be adjusted as follows:
 - ___ a. All Vx DISCONNECT, 50/60 Hz DISCONNECT, and MAIN DISCONNECT circuit breakers to OFF.
 - ___ b. All Vx ADJUST knobs fully counterclockwise.
 - ___ c. LOC/REM switch to LOC.
- ___ 4. Unfasten screws and remove top from power distribution box to be adjusted.
- ___ 5. Set site 400-Hz wall-mounted circuit breaker for IOU to be adjusted to ON.
- ___ 6. Apply power sequentially at power distribution box of IOU being adjusted as follows:
 - ___ a. V1 DISCONNECT circuit breaker to ON.
 - ___ b. V2 DISCONNECT circuit breaker to ON.
 - ___ c. V3 DISCONNECT circuit breaker to ON.
 - ___ d. MAIN DISCONNECT circuit breaker to ON.
 - ___ e. Press RESET switch.
- ___ 7. Listen for sound of air circulating in cabinet to ensure that its blower assembly is operating.
- ___ 8. Check percentage meter mechanical zero as follows:
 - ___ a. Set power distribution box METER SELECT switch to OFF.
 - ___ b. Observe that meter needle rests on left indicator line. If necessary, adjust needle to line with screw on front of meter.

- ___ 9. Connect multimeter to power distribution box EXTERNAL METER test points.
- ___ 10. Adjust voltage V1 as follows:
 - ___ a. Set METER SELECT switch to V1.
 - ___ b. Turn V1 ADJUST knob slowly clockwise until multimeter reads V1 voltage written on NOMINAL VOLTAGE label.
 - ___ c. Adjust potentiometer R4 on meter multiplier board until power distribution box percentage meter indicates 0 percent.



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Figure 10-33. Meter Multiplier Board Adjustment Potentiometers

___ 11. Adjust voltage V2 as follows:

- ___ a. Set METER SELECT switch to V2.
- ___ b. Turn V2 ADJUST knob slowly clockwise until multimeter reads V2 voltage written on NOMINAL VOLTAGE label.
- ___ c. Adjust potentiometer R5 on meter multiplier board until power distribution box percentage meter indicates 0 percent.

___ 12. Adjust voltage V3 as follows:

- ___ a. Set METER SELECT switch to V3.
- ___ b. Turn V3 ADJUST knob slowly clockwise until multimeter reads V3 voltage written on NOMINAL VOLTAGE label.
- ___ c. Adjust potentiometer R6 on meter multiplier board until power distribution box percentage meter indicates 0 percent.

___ 13. Disconnect multimeter.

___ 14. Set LOC/REM switch to REM.

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IOU Two-Port Multiplexer Power Supply Adjustment

Use this procedure to adjust the +5-V output voltage of the two-port multiplexer (TPM) power supply. The TPM power supply mounts alongside the logic chassis in an AT511-A cabinet and is accessed from the front of the cabinet.

NOTE

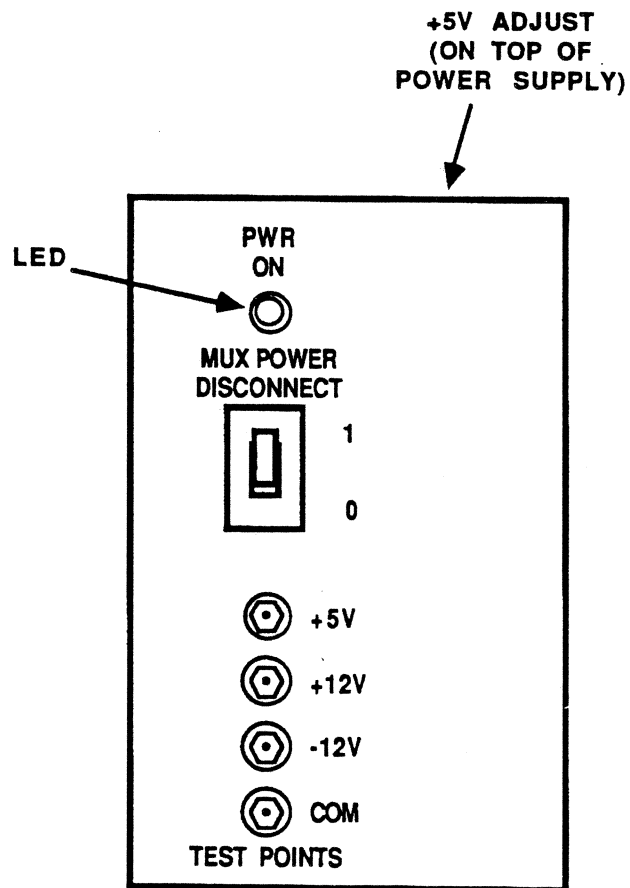
This procedure does not apply to an AT512-A cabinet.

Tools/parts required

- Insulated adjustment tool
- Digital multimeter (Fluke 8020A), CDC P/N 12263279

Procedure

- ___ 1. Set controls on power distribution box of IOU to be adjusted as follows:
 - ___ a. LOC/REM switch to LOC.
 - ___ b. MAIN DISCONNECT and 50/60 Hz DISCONNECT circuit breakers to ON.
- ___ 2. Set site 50/60-Hz wall-mounted circuit breaker for IOU to be adjusted to ON.
- ___ 3. Set site 400-Hz wall-mounted circuit breaker for IOU to be adjusted to ON.
- ___ 4. Set MUX POWER DISCONNECT circuit breaker on TPM power supply (figure 10-34) to ON, up position. Power supply PWR ON indicator lights.
- ___ 5. Connect multimeter to COM and +5 V test points on TPM power supply.
- ___ 6. Use insulated adjustment tool to turn +5 V ADJUST on top of TPM power supply until multimeter indicates +5.01 V.
- ___ 7. Disconnect multimeter.
- ___ 8. Set LOC/REM switch to REM.



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Figure 10-34. Two-Port Multiplexer Power Supply

IOU Cabinet Margin Tests

The margin tests verify that the bus voltage adjustment range is within ± 5 percent of the nominal voltage.

Tools/parts required

- Digital multimeter (Fluke 8020A), CDC P/N 12263279

Procedure

- ___ 1. Set controls on power distribution box of IOU being checked as follows:
 - ___ a. LOC/REM switch to LOC.
 - ___ b. All Vx DISCONNECT, 50/60 Hz DISCONNECT, and MAIN DISCONNECT circuit breakers to ON.
- ___ 2. Connect multimeter to power distribution box EXTERNAL METER test points.
- ___ 3. Select bus to be checked with METER SELECT switch.
- ___ 4. Turn ADJUST knob for selected bus counterclockwise until multimeter indicates lower margin voltage specified in table 10-1 for selected bus.

Table 10-1. Bus Voltage Margins

Bus	Lower Margins (V dc)	Upper Margins (V dc)
V1	-2.090	-2.310
V2	-4.940	-5.460
V3	+4.750	+5.250

- ___ 5. Repeat steps 3 and 4 for remaining buses.
- ___ 6. Turn Vx ADJUST knob for selected bus clockwise until multimeter indicates upper margin voltage specified in table 10-1 for selected bus.
- ___ 7. Repeat step 6 for remaining buses.
- ___ 8. Return each bus voltage level to voltage value written on NOMINAL VOLTAGE label.
- ___ 9. Set LOC/REM switch to REM.

Ripple Voltage Test

Use this procedure to measure ripple voltage on the buses of an IOU cabinet. The buses are accessed from the rear of the cabinet. Test points listed in table 10-2 is marked on the related bus.

Tools/parts required

- Oscilloscope (Tektronix 2465 with option 11), CDC P/N12263632

Procedure

1. Connect oscilloscope to each point listed in table 10-2, and ensure that displayed peak-to-peak ripple voltage does not exceed specified value.
2. Replace SCR associated with any bus displaying excessive ripple. (Refer to Power Supply SCR Removal/Replacement procedure.)

Table 10-2. Cabinet Bus Ripple Voltage

Logic Cage	Measuring Point	Peak-To-Peak Maximum Ripple (mV)
1A2-A1 (Upper Row)	White Bus, E1	30
	Blue Bus, E1	60
	Red Bus, E5	60
	White Bus, E6	30
1A2-A2 (Lower Row)	Blue Bus, E6	60
	Red Bus, E11	60

Diode Waveform Checks

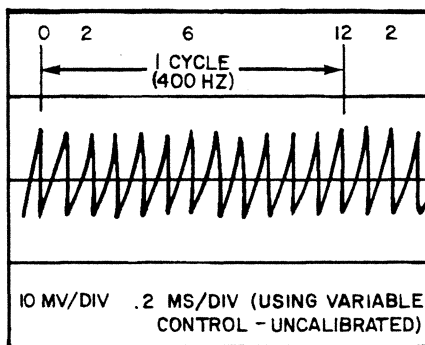
Use this procedure to perform diode waveform checks on the power diodes associated with transformers 1T1, 1T2, and 1T3. Refer to figures 10-35 and 10-36 while performing this procedure.

Tools/parts required

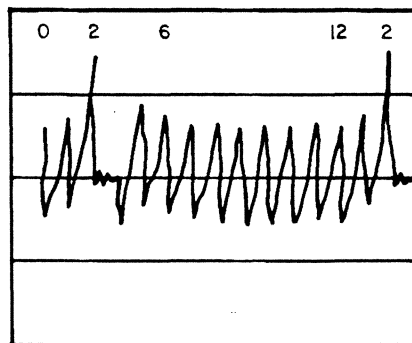
- Oscilloscope (Tektronix 2465 with option 11), CDC P/N 12263632

Procedure

- ___ 1. With power applied to cabinet, connect oscilloscope equipped with a 10X probe between the center tap bar of transformer 1T1, 1T2, or 1T3 (as appropriate) and cabinet chassis.
- ___ 2. Make oscilloscope connections/settings as follows:
 - ___ a. Synchronize externally to diode lead
 - ___ b. Set input coupling to ac
 - ___ c. Set sweep speed to -0.25 ms per division
- ___ 3. Display one complete 400-Hz rectification cycle (12 peaks) as shown in figure 10-35.



A.



B.

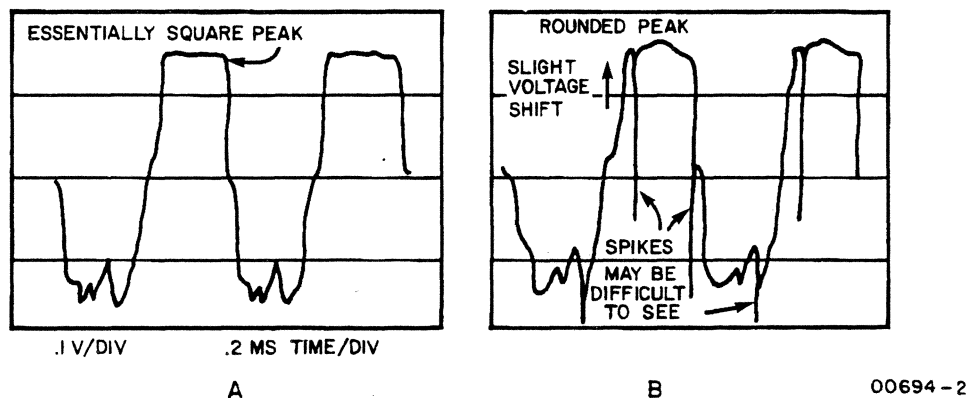
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NOTE

ALL WAVEFORMS SHOWN HAVE VOLTAGE
TRACE SET ON CENTER LINE.

Figure 10-35. 400-Hz, 3-Phase Rectification Cycle Waveform

- ___ 4. Determine if waveform is normal or defective.
- ___ 5. If waveform is normal, repeat steps 1 through 4 for untested transformers and diodes.
- ___ 6. If waveform appears defective, make additional comparisons to waveforms shown below. If waveform still appears to be defective, perform Diode Balance Check procedure.



NOTE

ALL WAVEFORMS SHOWN HAVE VOLTAGE
TRACE SET ON CENTER LINE.

Figure 10-36. Power Diode Waveforms

Diode Balance Check

This check allows comparison of the performance of each power diode associated with a particular power transformer.

Tools/parts required

- Clamp-on ammeter, ac
- Oscilloscope (Tektronix 2465 with option 11), CDC P/N12263632
- Digital multimeter (Fluke 8020A), CDC P/N 12263279

Procedure

- ___ 1. With power applied to cabinet, connect an ac clamp-on ammeter to each diode of selected power transformer and record current reading.
- ___ 2. Compare readings to each other as follows:
 - ___ a. If all readings are within 20 percent of each other, diodes are functioning correctly. Repeat steps 1 and 2 for the remaining transformers.
 - ___ b. If readings differ by more than 20 percent, go to step 3.
- ___ 3. Using table 10-3 as a guide, start making measurements at 400-Hz input to the particular power supply. Test each component for ac ripple, working toward dc bus outputs until problem is located. If measured ripple greatly exceeds permissible limits, look for small imbalances in current and voltage readings.
- ___ 4. When area of trouble is located, eliminate the possibility of a bad connection, a bad wire, or a wiring error before replacing a component. Then remeasure ripple. If ripple is still high, return to a point before the trouble area and continue ripple measurements.

Table 10-3. Diode Troubleshooting Guide

Measurement	Equipment	Measure At
Transformer input voltages (ac)	Digital multimeter	Phase-to-phase
Bad connection or bad wire	Digital multimeter	Across connection or across opposite ends of wire
Diode forward voltage drop	Oscilloscope	Across diode
Current in diode	ac clamp-on ammeter	Diode lead
Transformer secondary voltage	Digital multimeter	Leg-to-leg

Transient Protect Test

Use the following procedure to test a cabinet's response to a momentary loss of input power.

Procedure

- ___ 1. With power applied to cabinet to be tested, set controls of power distribution box as follows:
 - ___ a. LOC/REM switch to LOC.
 - ___ b. All Vx DISCONNECT, 50/60 Hz DISCONNECT, and MAIN DISCONNECT circuit breakers to ON.
- ___ 2. Cabinet blower starts and power distribution box POWER ON indicator lights.
- ___ 3. Press and release TEST switch. Observe following:
 - ___ a. All Vx DISCONNECT circuit breakers trip to OFF.
 - ___ b. All Vx FAULT indicators light.
 - ___ c. POWER ON indicator goes out.
 - ___ d. Cabinet blower stops.
- ___ 4. Press and release RESET switch. Observe following:
 - ___ a. CIRCUIT BREAKER OFF/TRIP indicator lights.
 - ___ b. All Vx FAULT indicators go out.
- ___ 5. Set all Vx DISCONNECT circuit breakers to ON.
- ___ 6. Press and release RESET switch. Observe following:
 - ___ a. CIRCUIT BREAKER OFF/TRIP indicator goes out.
 - ___ b. POWER ON indicator lights.
 - ___ c. Cabinet blower starts.
- ___ 7. Set LOC/REM switch to REM.

Bus Voltage Error Detection

The following procedure checks a cabinet's response to out-of-limit bus voltages.

Tools/parts required

- Digital multimeter (Fluke 8020A), CDC P/N 12263279
- Clamp-on ammeter, dc

Procedure

- ___ 1. Set controls on power distribution box of cabinet being checked as follows:
 - ___ a. LOC/REM switch to LOC.
 - ___ b. All V_x DISCONNECT, 50/60 Hz DISCONNECT, and MAIN DISCONNECT circuit breakers to OFF.
- ___ 2. Remove all logic modules from cabinet according to Logic Module Removal/Replacement.
- ___ 3. Connect multimeter to power distribution box EXTERNAL METER test points.
- ___ 4. Connect dc ammeter clamp to white gate wire on SCR for bus being checked, table 10-4.

Table 10-4. Buses, SCRs, and Fault Levels

Bus	SCR	Fault Detect Voltage (Maximum)
-2.2 V dc, V1, white	1CR39	-2.6 $\pm$ 0.30 V dc
-5.2 V dc, V2, blue	1CR38	-6.0 $\pm$ 0.60 V dc
+5.0 V dc, V3, red	1CR37	+5.8 $\pm$ 0.58 V dc

- ___ 5. Set METER SELECT switch to select bus being checked.
- ___ 6. Set all V_x DISCONNECT, 50/60 Hz DISCONNECT, and MAIN DISCONNECT circuit breakers to ON.
- ___ 7. Turn V_x ADJUST knob (for bus being checked) clockwise. Stop when either multimeter indicates maximum fault detect voltage in table 10-4 or V_x FAULT indicator lights.
- ___ 8. If maximum fault detect voltage in table 10-4 is reached and a fault is not detected, replace the cabinet's power distribution box according to Power Distribution Box Removal/Replacement procedure.

- ___ 9. If Vx FAULT indicator lights, observe following:
 - ___ a. Multimeter indicates 0 volt.
 - ___ b. Vx DISCONNECT circuit breaker is off.
 - ___ c. DC ammeter indicates 0.15 ± 0.03 A.
 - ___ d. POWER ON indicator goes out.
- ___ 10. Turn Vx ADJUST (for bus just checked) counterclockwise to its approximate starting position (step 7).
- ___ 11. Press and release RESET switch. Observe following:
 - ___ a. Vx FAULT indicator goes out.
 - ___ b. CIRCUIT BREAKER OFF/TRIP indicator lights.
- ___ 12. Set Vx DISCONNECT circuit breaker (for bus just checked) to ON.
- ___ 13. Press and release RESET switch. Observe following:
 - ___ a. All faults clear.
 - ___ b. CIRCUIT BREAKER OFF/TRIP indicator goes out.
 - ___ c. POWER ON indicator lights.
- ___ 14. Turn Vx ADJUST knob (for bus just checked) until multimeter reads voltage written on NOMINAL VOLTAGE label for this bus.
- ___ 15. Set all Vx DISCONNECT, 50/60 Hz DISCONNECT and MAIN DISCONNECT circuit breakers to OFF.
- ___ 16. Repeat steps 4 through 15 for remaining buses.
- ___ 17. Replace logic modules in cabinet according to Logic Module Removal/Replacement procedure in this chapter.
- ___ 18. Set all Vx DISCONNECT, 50/60 Hz DISCONNECT, and MAIN DISCONNECT circuit breakers to ON.
- ___ 19. Set LOC/REM switch to REM.

Heat Sink Temperature Checks

Use this procedure to test the temperature sensors (1TS2 or 1TS3) on the power diode heat sink.

Tools/parts required

- Low-temperature heat gun or hair dryer

Procedure

- ___ 1. Set controls on power distribution box of IOU cabinet being checked as follows:
 - ___ a. LOC/REM switch to LOC.
 - ___ b. All Vx DISCONNECT, 50/60 Hz DISCONNECT, and MAIN DISCONNECT circuit breakers to ON.

⚠ CAUTION

Do not direct heat gun output on solder connections of temperature sensor.

- ___ 2. Apply heat to temperature sensor with low-temperature heat gun or hair dryer while observing following:
 - ___ a. HEAT SINK HIGH TEMP indicator lights.
 - ___ b. After a maximum of 2 minutes, POWER ON indicator goes out (dc voltage to all buses removed).
 - ___ c. Cabinet blower assembly stops.
- ___ 3. Remove heat to temperature sensor.
- ___ 4. Press and release RESET switch, and observe following:
 - ___ a. HEAT SINK HIGH TEMP indicator goes out.
 - ___ b. POWER ON indicator lights.
 - ___ c. Cabinet blower assembly starts.
- ___ 5. Repeat steps 1 through 4 for other heat sink temperature sensor.
- ___ 6. Set LOC/REM switch to REM.

Backup Thermostat Checks

Use this procedure to test the backup thermostats (1S1 or 1S2) on the power diode heat sink.

Tools/parts required

- Low-temperature heat gun or hair dryer

Procedure

- ___ 1. Set controls on power distribution box of IOU cabinet being checked as follows:
 - ___ a. LOC/REM switch to LOC.
 - ___ b. All Vx DISCONNECT, 50/60 Hz DISCONNECT, and MAIN DISCONNECT circuit breakers to OFF.
- ___ 2. Remove screws securing thermostat to heat sink (refer to Thermostat Removal/Replacement procedure). Pull assembly clear of heat sink, but leave its cable connected.
- ___ 3. Set all Vx DISCONNECT, 50/60 Hz DISCONNECT, and MAIN DISCONNECT circuit breakers to ON.
- ___ 4. Apply heat to thermostat with low-temperature heat gun or hair dryer while observing following:
 - ___ a. All Vx DISCONNECT circuit breakers trip to OFF.
 - ___ b. POWER ON indicator goes out (dc voltage to all buses removed).
 - ___ c. BACKUP indicator lights.
- ___ 5. Remove heat to thermostat, and install it on heat sink.
- ___ 6. Press and release RESET switch, and observe following:
 - ___ a. BACKUP indicator goes out.
 - ___ b. CIRCUIT BREAKER OFF/TRIP indicator lights.
- ___ 7. Set all Vx DISCONNECT circuit breakers to ON.
- ___ 8. Press and release RESET switch, and observe following:
 - ___ a. CIRCUIT BREAKER OFF/TRIP indicator goes out.
 - ___ b. POWER ON indicator lights.
- ___ 9. Repeat steps 1 through 8 for other heat sink thermostat.
- ___ 10. Set LOC/REM switch to REM.

Circuit Breaker Off Sense

This procedure tests the operation of the circuit breaker off sensing circuit.

Procedure

- ___ 1. Apply power to cabinet to be checked.
- ___ 2. On power distribution box for cabinet, set LOC/REM switch to LOC.
- ___ 3. Set any one of the Vx DISCONNECT circuit breakers to OFF and observe following:
 - ___ a. Remaining Vx voltages go to zero and blower stops.
 - ___ b. CIRCUIT BREAKER OFF/TRIP lights.
 - ___ c. POWER ON indicator goes out.
- ___ 4. Set all Vx DISCONNECT circuit breakers to ON.
- ___ 5. Press and release RESET switch, and observe following:
 - ___ a. CIRCUIT BREAKER OFF indicator goes out.
 - ___ b. POWER ON indicator lights.
- ___ 6. Repeat steps 3 through 5 for remaining Vx DISCONNECT circuit breakers.
- ___ 7. Set LOC/REM switch to REM.

Airflow Sense

This procedure checks the operation of a cabinet's blower airflow sensing circuit.

Procedure

- ___ 1. Apply power to cabinet to be checked.
- ___ 2. Set controls on power distribution box of IOU cabinet being checked as follows:
 - ___ a. LOC/REM switch to LOC.
 - ___ b. MAIN DISCONNECT circuit breaker to OFF.
 - ___ c. 50/60 Hz DISCONNECT circuit breaker to OFF.
- ___ 3. Set MAIN DISCONNECT circuit breaker to ON and observe following:
 - ___ a. Blower assembly does not start.
 - ___ b. Within three minutes, BLOWER FAULT indicator on power distribution box lights, and one minute later POWER ON indicator goes out.
- ___ 4. Set MAIN DISCONNECT circuit breaker to OFF.
- ___ 5. Set 50/60 Hz DISCONNECT circuit breaker to ON.
- ___ 6. Set MAIN DISCONNECT circuit breaker to ON.
- ___ 7. Press and release RESET switch, and observe following:
 - ___ a. Blower assembly starts.
 - ___ b. POWER ON indicator lights.
 - ___ c. BLOWER FAULT indicator goes out after one minute.
- ___ 8. Set LOC/REM switch to REM.

Tables 11-1 and 11-2 provide the part number, description, and reference designator (if applicable) for each field replaceable unit (FRU).

Figures 11-1 and 11-2 provide selective location information that, when used in combination with the figures and procedural information in chapter 10, allows accurate identification of the spared FRUs.

Figures 11-3 and 11-4 show the logic chassis locations for the spared logic module assemblies.

Table 11-1. AT511-A Input/Output Unit FRUs

Part Number	Description	Reference Designator
00815437	Washable filter	
22133906	Temperature sensor assembly	1TS1 - 1TS4
24564219	Thermostat	1S1, 1S2
37101712	Rectifier, silicon controlled	1CR38, 1CR39
18840102	Diode	1CR1 - 1CR12
18937300	Diode	1CR13 - 1CR24
18937301	Diode	1CR25 - 1CR36
12117309	Capacitor, 18 000 μ F, 10 V dc	1C1 - 1C20
53577060	Cable assembly, ISI channel	
22132510	Cable assembly, IPI channel	
19266534	Cable assembly, CYBER 170 channel	
19268401	Cable assembly, TPM back panel	
22845800	Transformer, 6.6 V, 400 A	1T2
12152300	Transformer, 5.2 V, 750 A	1T3
15182000	Transformer, -3.0 V, 400 A	1T1
53600603	Power distribution box assembly	1A4
15385077	Capacitor, 40 V dc, 12 000 μ F	1A4C1
15005251	Circuit breaker, 400 Hz	1A4CB4
15385076	Capacitor, 6300 μ F	1A4C2
18435600	Voltmeter, DC external multimeter	1A4M1
18556511	Voltmeter multiplier assembly	(part of 1A4M1)
18440703	Circuit breaker, auxiliary switch	1A4CB2, 1A4CB3
18440720	Circuit breaker, 400 Hz, auxiliary switch	1A4CB1
15005180	Circuit breaker, 50/60 Hz	1A4CB6
18906200	Relay, 4PDT, 25 A	1A4K1, 1A4K2
18906205	Relay, 4PDT, 25 A	1A4K4
22679707	Power warning board	1A4A1
12089201	Relay, 250 mA	1A4A1K6
52948188	Relay, latching	1A4A1K7
23253800	Transformer, variable, 5 kVA	1A4T2, 1A4T3
30090600	Transformer, variable, 3 kVA	1A4T1
50242201	Bridge rectifier, 30 A, 100 V	1A4CR1
51683710	Circuit breaker, 1P, 250 V	1A4CB5
52807821	Contactor, 40 A, 50-400 Hz,	1A4K3
53973800	Transformer, stepdown 0.75 kVA	1A4T5
94346400	Transformer, power	1A4T4

(Continued)

Table 11-1. AT511-A Input/Output Unit FRUs (Continued)

Part Number	Description	Reference Designator
22786541	Blower assembly	1A1B1
53600650	Sensor assembly, airflow and cable	1A1A1
53600632	Two-port multiplexer power supply	1A7
96744777	Filter, RFI	1A5FL1
15473131	Filter, RFI	1A5FL2
77966910	Power multiplexer board	1A3
96785601	Contact strip, adhesive-back	
41659600	Logic module, 1HAH	
41650233	Logic module, 1KBH	
41651006	Logic module, 1JFH	
41653035	Logic module, 1KRH	
41653806	Logic module, 1JVH	
41654802	Logic module, 1KAH	
41653006	Logic module, 1JRH (if AT515-A is installed)	
41655802	Logic module, 1HRH (if AT514-A is installed)	
41656001	Logic module, 1HGH	
41656200	Logic module, 1HHH	
41656400	Logic module, 1HJH	
41657000	Logic module, 1HQH	
41657200	Logic module, 1HSH	
41657400	Logic module, 1HTH	
41657601	Logic module, 1HXH	
41658600	Logic module, 1HCH	
41658800	Logic module, 1HMH	
41659000	Logic module, 1HWH	
41656800	Logic module, 1HLH	
41657800	Logic module, 1KLH	
41656602	Logic module, 1HKH	
41654404	Logic module, 1JYH	
41654203	Logic module, 1JXH	
41654604	Logic module, 1JZH	
41655401	Logic module, 1LXH	
41655601	Logic module, 1LZH	
41655001	Logic module, 1KXH	
41655203	Logic module, 1KZH	

Table 11-2. AT512-A Input/Output Unit FRUs

Part Number	Description	Reference Designator
00815437	Washable filter	
22133906	Temperature sensor assembly	1TS1 - 1TS4
24564219	Thermostat	1S1, 1S2
37101712	Rectifier, silicon controlled	1CR37 - 1CR39
18840102	Diode	1CR1 - 1CR12
18840300	Diode	1CR13 - 1CR24
18937301	Diode	1CR25 - 1CR36
12117309	Capacitor, 18 000 μ F, 10 V dc	1C1 - 1C20
53577060	Cable assembly, ISI channel	
22132510	Cable assembly, IPI channel	
19266534	Cable assembly, CYBER 170 channel	
22845800	Transformer, 6.6 V, 400 A	1T2
12152300	Transformer, 5.2 V, 750 A	1T3
15182000	Transformer, -3.0 V, 400 A	1T1
53600603	Power distribution box assembly	1A4
15385077	Capacitor, 40 V dc, 12 000 μ F	1A4C1
15005251	Circuit breaker, 400 Hz	1A4CB4
15385076	Capacitor, 6300 μ F	1A4C2
18435600	Voltmeter, DC external multimeter	1A4M1
18556511	Voltmeter multiplier assembly	(part of 1A4M1)
18440703	Circuit breaker, auxiliary switch	1A4CB2, 1A4CB3
18440720	Circuit breaker, 400 Hz, auxiliary switch	1A4CB1
15005180	Circuit breaker, 50/60 Hz	1A4CB6
18906200	Relay, 4PDT, 25 A	1A4K1, 1A4K2
18906205	Relay, 4PDT, 25 A	1A4K4
22679707	Power warning board	1A4A1
12089201	Relay, 250 mA	1A4A1K6
52948188	Relay, latching	1A4A1K7
23253800	Transformer, variable, 5 kVA	1A4T2, 1A4T3
30090600	Transformer, variable, 3 kVA	1A4T1
50242201	Bridge rectifier, 30 A, 100 V	1A4CR1
51683710	Circuit breaker, 1P, 250 V	1A4CB5
52807821	Contactor, 40 A, 50-400 Hz,	1A4K3
53973800	Transformer, stepdown 0.75 kVA	1A4T5
94346400	Transformer, power	1A4T4
22786541	Blower assembly	1A1B1
53600650	Sensor assembly, airflow and cable	1A1A1
96744777	Filter, RFI	1A5FL1
15473131	Filter, RFI	1A5FL2
77966910	Power multiplexer board	1A3
96785601	Contact strip, adhesive-back	
41650233	Logic module, 1KBH	
41653035	Logic module, 1KRH	
41654802	Logic module, 1KAH	
41656001	Logic module, 1HGH	
41656200	Logic module, 1HHH	
41656400	Logic module, 1HJH	
41657200	Logic module, 1HSH	
41659000	Logic module, 1HWH	

(Continued)

Table 11-2. AT512-A Input/Output Unit FRUs *(Continued)*

Part Number	Description	Reference Designator
41659600	Logic module, 1HAH	
41657400	Logic module, 1HTH	
41653806	Logic module, 1JVH	
41651006	Logic module, 1JFH	
41658600	Logic module, 1HCH	
41654404	Logic module, 1JYH	
41654203	Logic module, 1JXH	
41654604	Logic module, 1JZH	
41655401	Logic module, 1LXH	
41655602	Logic module, 1LZH	
41655001	Logic module, 1KXH	
41655203	Logic module, 1KZH	

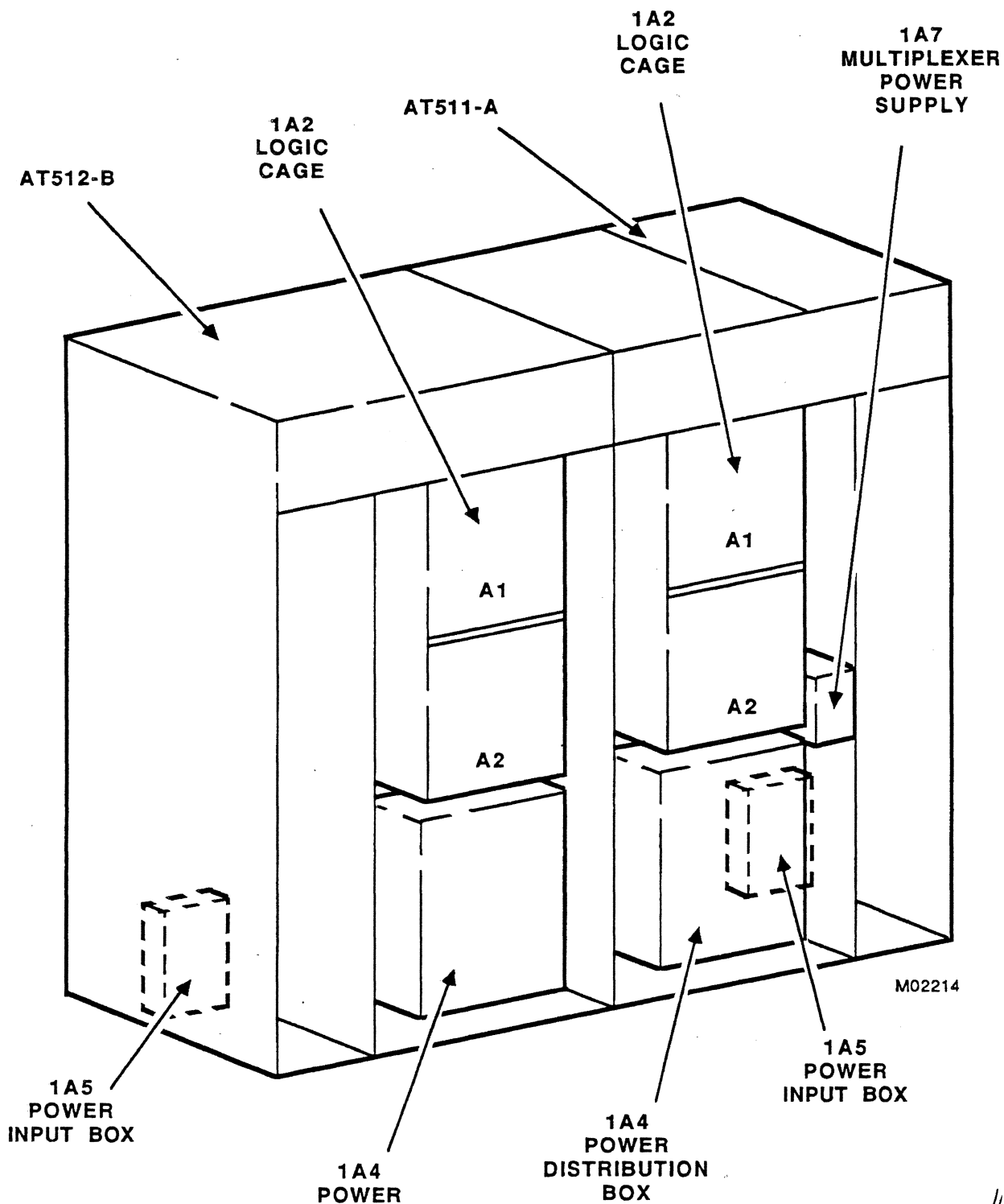


Figure 11-1. Cabinet Front View, Selected Assembly Locator

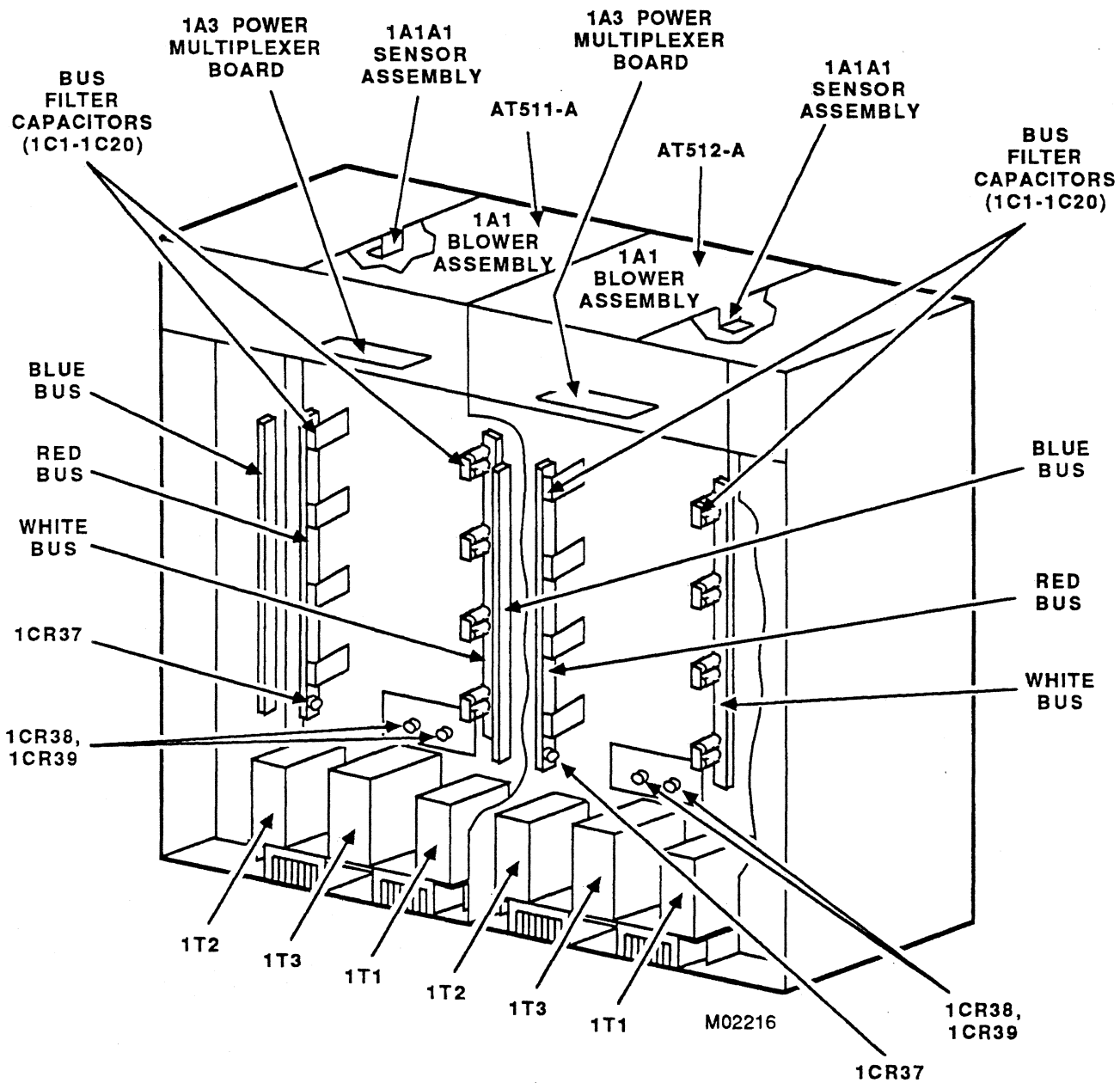


Figure 11-2. Cabinet Rear View, Selected Assembly Locator

1A2A1																												
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
1 K A H	*	1 J Y H	*	*	1 J Y H	*	*	1 J Y H	*	*	1 J Y H	*	*	1 J Y H	*	1 H W H	1 K R H	1 K B H	1 J A H	1 H T H	1 J V H	1 J F H	1 H C H	1 H X H	1 H X H	1 H X H	1 H X H	
CIO CHAN 5-11 CIO BAS 1 C L K M R / A D U C O N T ADU DISASSY ADRS CMM CM R/TS																												
← EXT DM A BAS 1 →																												
		5	5	5	6	6	6	7	7	7	10	10	10	11	11	11												

1A2A2																													
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28		
1 H Q H	1 H M H	1 H L H	1 K L H	1 K A H	*	1 J Y H	*	*	1 J Y H	*	*	1 J Y H	*	1 H W H	1 K R H	1 K B H	1 H S H		1 J K H	1 - R H	1 H J H	1 H H H	1 H H H	1 H G H	1 H H H	1 H H H	1 H J H		
M A C	U T C	I C C	S C S I	C I O C H A N 2-4											C I O B A S 0		M R		T P M	1 - R H	← C M I →		A D R S	D A T A	D A T A	C O N T	D A T A	D A T A	A D R S
				1																									
			32 / 33		E X T I / F 2	D M A A D U 2	B A S I / F 2													1 / 2 / 3									

M02218

NOTES:



CHANNEL-TYPE IS SPECIFIED BY CUSTOMER:

AT490-A IS AN ISI/DMA CHANNEL AND USES 1JXH AT LOCATION * AND A 1JZH AT LOCATION **.

AT497-A IS AN IPI/DMA CHANNEL AND USES 1LXH AT LOCATION * AND A 1LZH AT LOCATION **.

AT498-A IS A CYBER 170/DMA CHANNEL AND USES A 1KXH AT LOCATION * AND A 1KZH AT LOCATION **.



LOGIC MODULE IS 1HRH IF AT514-A IS INSTALLED OR 1JRH IF AT515-A IS INSTALLED.

Figure 11-3. AT511-A Logic Cage Location Assignments

1A2A1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1 K A H	*	1 J Y H	*	*	1 J Y H	*	*	1 J Y H	*	*	1 J Y H	*	*	1 J Y H	*	1 H W H	1 K R H	1 K B H	1 J A H	1 H T H	1 J V H	1 J F H	1 H C H				
△ 2																△ 2	△ 2	△ 2	CLK								

1A2A2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1 K A H	*	1 J Y H	*	*	1 J Y H	*	*	1 J Y H	*	*	1 J Y H	*	*	1 J Y H	*	1 H W H	1 K R H	1 K B H		1 H S H	1 H J H	1 H H H	1 H H H	1 H G H	1 H H H	1 H H H	1 H J H
CIO CHAN 20-24											CIO BAS 2																
←											→									→							
△ 1																				M R							
																				C M I							

M02220

NOTES:



CHANNEL-TYPE IS SPECIFIED BY CUSTOMER:

AT490-A IS AN ISI/DMA CHANNEL AND USES 1JXH AT LOCATION * AND A 1JZH AT LOCATION **.

AT497-A IS AN IPI/DMA CHANNEL AND USES 1LXH AT LOCATION * AND A 1LZH AT LOCATION **.

AT498-A IS A CYBER 170/DMA CHANNEL AND USES A 1KXH AT LOCATION * AND A 1KZH AT LOCATION **.



PROVIDED AS A PART OF AT513-A.

Figure 11-4. AT512-A Logic Cage Location Assignments

Glossary

A

A

A Register

Address register.

AC

Address control.

Address

A sequence of bits, a character, or a group of characters that identifies a network station, user, or application.

Adrs

Address.

ADU

Assembly/disassembly unit in the input/output unit.

ALN

Arithmetic/logical network.

Alphabetic character

One of the following letters: A through Z, a through z.

ALU

Arithmetic logic unit.

American Standard Code for Information Interchange (ASCII)

The standard code, using a coded character set consisting of 7-bit coded characters (8-bits including parity check), used for information interchange among data processing systems, data communication systems, and associated equipment. The ASCII set consists of control characters and graphic characters.

AOR

Address out-of-range.

ASCII

See American Standard Code for Information Interchange.

ASID

Active segment identifier.

Autotransformer

Any transformer of single coil construction where the primary and secondary connections are made to the single coil, and used to change voltage amplitudes.

AUX

Auxiliary.

B**B Register**

Index register.

BAS

Barrel and slot in the input/output unit.

BC

Base constant.

BCD

Binary-coded decimal.

BDP

Business data processor.

Binary Synchronous Communications (BISYNC)

A communications term that means running in two directions at alternate times. A bisync line is one that allows a device to both send and receive data.

BISYNC

See Binary Synchronous Communications.

BMRS

Broadcast master reset.

BN

Byte number.

Board

See Logic Module.

BS

Binding section.

BSA

Bit significant address.

BSP

Binding section pointer.

BSR

Bit significant response.

BSS

Bus slave select.

C

C Register

Carrier

A continuous frequency capable of being modulated or impressed with a signal.

CB

Circuit breaker.

CBP

Code base pointer.

CCEL

Cache corrected error log.

CDC

Control Data Corporation.

CDD

Cable configuration dependent.

CE

Customer engineer.

CEJ

Central exchange jump.

CEL

Corrected error log.

CEM

Configuration environment monitor.

Central Memory (CM)

The main memory of the CYBER 960/962 within the central processing unit cabinet. CM stores between 64 and 256 megabytes of data on 4 to 16 memory modules. CM hardware includes memory modules, a dedicated logic cage, a memory interface module, and voltage regulator modules.

Central Memory Control (CMC)

The logic element in the CPU that controls the movement of data between central memory (CMCA and CMCB) and the central processor. The CMC circuits reside on two logic modules located in the CP-0 logic cage, but accomplish memory control for both CP-0 and CP-1.

Central Processing Unit (CPU)

The main processing cabinet in the CYBER 960 Series mainframe, which includes the central processor (CP-0 and CP-1), central memory control, and central memory. The CPU cabinet has up to two central processors and between 64 and 256 megabytes of resident memory.

Central Processor (CP)

The functional processing logic within the CYBER 960/962 CPU. The first (or standard) central processor is referred to as CP-0. If a second central processor is provided with a system, it is referred to as CP-1. Each central processor resides in a separate logic cage and consists of eleven logic modules.

CF

Critical frame pointer.

CFF

Critical frame flag.

Chan

Channel.

Character

1. Any alphabetic, numeric, or special symbol that can be encoded. This term applies to the graphic characters for a input or output device and to the encoded control characters used by the terminal. Within Control Data hardware, a character is a coded byte of data, such as a 6-bit display code (NOS only) or 7-bit ASCII code. 2. (ISO) A member of a set of elements upon which agreement has been reached, and that is used for the organization, control, or representation of information. Characters may be letters, digits, punctuation marks, or other symbols. A character can be a graphic character or a control character.

CIO

See Concurrent Input/Output.

CIP

CYBER Initialization Package.

CLK

See Clock.

Clock (CLK)

1. (ISO) A device that generates periodic signals used for synchronization. 2. (ISO) Equipment that provides a time base used in a transmission system to control the timing of certain functions such as sampling and the duration of signal elements. See also Real Time.

CM

See Central Memory.

CMC

See Central Memory Control.

CMI

Control memory interface in the input/output unit.

CML

Concurrent maintenance library.

CML/VE

Concurrent maintenance library/virtual environment.

CMM

Central memory multiplexer in the input/output unit.

CMSE

Common maintenance software executive.

Coded Character Set

(ISO) A set of unambiguous rules that establish a character set and the one-to-one relationships between the characters of the set and their coded representation.

Computer room

A room that has a controlled environment that is maintained to meet the requirements of the system equipment.

Concurrent Input/Output (CIO)

An input/output unit architecture that functions with the NOS/VE operating system.

CP

See Central Processor. See also Central Processing Unit.

CPU

See Central Processing Unit.

CSF

Current stack frame.

CSSC

Customer services support center.

CST

Control store.

CST/MAC

Control store/maintenance access control.

CTI

Common test and initialization.

CYBER 960 Series (960/962) Computer Systems

Includes CYBER 960 and CYBER 962 computer systems. The CYBER 960 Series is Control Data's state-of-the-art middle- to high-range system, flanked by the 930 departmental computer on the low end and the 990 computer on the high end of the scalar performance spectrum. A full 960 system includes the mainframe (CPU, IOU, and power unit), MG set, system console, operating software, and a complement of peripherals.

CY170

CYBER 170.

C170

CYBER 170.

C180

CYBER 180.

D**D/F**

Data/function bit.

DC

1. Direct current. 2. Debug code.

DCD

Data carrier detector.

Deadstart

The process of initializing the system by loading the operating system library programs and any of the product set from magnetic tape or disk. Deadstart recovery is reinitialization after system failure.

DEC

Dependent environment control.

Demodulation

The process of retrieving an original data signal from a modulated carrier wave.

Device Interface (DI)

The communications processor that Control Data offers as its CDCNET hardware product. Also called a CDCNET device interface.

DI

1. Debug index. 2. See Device Interface.

Digit

One of the following characters: 0 1 2 3 4 5 6 7 8 9.

DLP

Debug list pointer.

DM

Debug mask.

DMA

Direct-memory access.

DMR

Debug mask register.

Down

A status of suspended service.

DS

See Deadstart.

DSC

Display station controller.

DSP

Dynamic space pointer.

DSR

Data set ready.

DTR

Data terminal ready.

Dual IOU

An IOU installation containing a standard (attached) IOU and a standalone IOU.

DUE

Dependent environment control.

DVS

Diagnostic virtual system.

E**EBCDIC**

See Expanded Binary Coded Decimal Interchange Code.

EC

Environment control.

ECL

Error correction code. //PUB

Emitter-coupled logic.

ECM

Extended central memory.

ECS

Extended core storage.

EI

Environmental interface.

EIA

Electronics Industries Association.

EID

Element identifier.

Ellipsis

Three (or more) consecutive periods at the end of a physical line to indicate the continuation of a command.

EM

Error mode.

EPF

External procedure flag.

EQ

Equal.

ES

End suppression toggle (BDP edit instruction).

ESD

Electrostatic discharge.

ESM

Extended semiconductor memory.

ESM-II

Extended semiconductor memory II.

Expanded Binary Coded Decimal Interchange Code (EBCDIC)

The set of 256 characters, each presented by eight bits, that is used with the 3270 Binary Synchronous Communications protocol.

EXT

External.

F**FCC**

Federal Communication Compliance.

FCO

Field change order.

FCTN

Function.

Federal Communication Compliance (FCC)

This equipment generates, uses and can radiate radio frequency energy and if not installed and used in accordance with the instructions manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device (insert peripheral computing device if appropriate) pursuant to Subpart J of Part 15 of the FCC Rules which are designed to provide reasonable

protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user, at his own expense, will be required to take whatever measures may be required to correct the interference.

FF

See Flip-Flop.

Field-Replaceable Unit (FRU)

Equipment parts that are replaceable at the customer site are referred to as FRUs. Equipment manuals generally recommend a list of FRUs that should be stocked on site for that equipment. FRUs are identified with 8-digit part numbers that can be ordered from Control Data's World Distribution Center (WDC). See also World Distribution Center.

FIFO

See First-In/First-Out.

First-In/First-Out (FIFO).

1. This term applies to data processing services in which requests are serviced in the same order they are received. 2.(ANDIPS) A queuing technique in which the item that has been in the queue for the longest time is the next to be processed.

FL

Field length.

FLC

Central memory field length register.

FLE

Extended core storage field length register.

Flip-Flop

(ANDIPS) A circuit or device containing active elements, capable of assuming either one of two stable states at a given time. Synonymous with bistable circuit, toggle (1).

Floating-Point Base

(ISO) In a floating-point representation system, the implicit fixed positive integer base, greater than unity, that is raised to the power explicitly denoted by the exponent in the floating-point representation or represented by the characteristic in the floating-point representation and then multiplied by the fixed-point part to determine the real number represented, e.g., in the floating-point representation of the number 0.0001234, namely 0.1234-3, the implicit floating-point base is 10. Synonymous with floating-point radix.

FP

Floating-point. See Floating-Point Base.

FRC

Free-running counter.

Frequency converter

A motor generator mounted within its control cabinet.

FRU

See Field-Replaceable Unit.

FS

Fault status.

FU

Functional unit.

G**G/L**

Global/local.

Graphic Character

(ISO) A character other than a control character, that is normally represented by a graphic.

H**Hardware**

1.(ISO) Physical equipment as opposed to programs, procedures, rules, and associated documentation. 2. Electronic circuits and its housing, including cabinet, power hook-up, and cooling system.

Hdr

Header.

Hertz (Hz)

A measure of frequency or band width the same as cycles per second.

HEX

See Hexadecimal.

Hexadecimal

(ISO) Synonym for sexadecimal. See also Sexadecimal.

HPA

Hardware Performance Analyzer.

HPA/VE

Hardware performance analyzer/virtual environment.

Hz

See Hertz.

I**I/F**

See Interface.

I/O

Input/output.

IC

Integrated circuit.

ICC

Instruction completion control.

ID

1. Identification. 2. Identifier.

IF

Instruction fetch.

IF/IC

Instruction fetch/instruction control.

ILH

Instruction look-ahead.

Input/Output Unit (IOU)

IOU contains the peripheral processors and channels that enable operator interaction with, and peripherals access to, the central processing unit. The IOU has either NOS and NOS/VE capability (CYBER 960) or is NOS/VE only (CYBER 962). The IOU has the interface port for the system console.

INSTR

Instruction.

Interface

1. A shared boundary. An interface might be a hardware component to link two devices or it might be a portion of storage or registers accessed by two or more computer programs. 2. See data transmission interface.

International Standards Organization (ISO)

A worldwide standards group similar in function to the American National Standards Institute (ANSI). ANSI is a member of the International Standards Organization.

IOU

See Input/Output Unit.

IOU Expansion

An add-on IOU product that physically attaches to the CYBER 960 IOU. The IOU expansion is a concurrent input/output (CIO) architecture and allows for addition of up to ten peripheral processors and ten channels. The IOU expansion is the first IOU option to be added to a CYBER 960 mainframe, increasing the number of IOU cabinets to two.

IPI

Intelligent peripheral interface channel architecture in the IOU.

ISI

Intelligent standard interface channel architecture in the IOU.

ISO

See International Standards Organization.

J**JPS**

Job process state.

K**K Register**

Operation code register.

KEY

Key.

L**Large-Scale Integrated Circuit**

A chip that contains around 100 to 1000 logical gates.

LDS

Literature Distribution Services.

LED

Light-emitting diode.

LM

See Local Memory.

LOC

Local.

Local Memory (LM)

The storage area with accompanying control that provides a high-speed interface between the central processor and central memory. LM is contained by two logic modules, LMA and LMB. See also Cache.

LOCK

Lock.

Logic Module

A printed-circuit board with microcircuit chips.

Long Warning (LW)

The power unit generates an LW when an emergency power shutdown is to occur in approximately 1 minute if the fault is in an IOU or in approximately 2 minutes if the fault is in the power unit, CPU cabinet, or with ambient room temperature (assuming the detected fault continues).

LPID

Last processor identification.

LRN

Largest ring number.

LSB

Least significant bit.

LSI

See Large-Scale Integrated Circuit.

LW

See Long Warning.

M**MA**

Monitor address.

MAC

Maintenance access control.

MAF

Maintenance action form.

Mainframe

Includes the central processing unit, input/output unit, and power unit portions of the mainframe complex. The mainframe does not include the motor-generator set or the system console.

Mainframe Complex

The hardware products that make up a central processing computer system are referred to collectively as the mainframe complex. Includes the central processing unit, input/output unit, power unit, system console, and the motor-generator set. Peripherals are not included in the mainframe complex.

MAINT

Maintenance.

MALET

Maintenance application language for equipment testing.

MCEL

Map corrected error log.

MCH

Maintenance channel.

MCR

Monitor condition register.

MCU

Maintenance control unit.

MD

Multiply/divide.

MDD

Monitor display driver.

MDF

Model-dependent flags.

MDW

Model-dependent word.

MEJ

Monitor exchange jump.

Memory Interface Module

The logical assembly interfacing central memory and central memory control. The memory interface module is physically attached to the rear of the central memory logic cage and includes circuits for data, addressing, and control.

Memory Module

The logical assembly upon which data is stored in central memory. Four memory modules constitute one memory increment or 64 megabytes of data storage. The central processing unit's central memory contains a minimum of four memory modules and a maximum of 16.

Meter

A unit of measure in the metric system that is equal to 39.3 inches.

MF

Monitor flag.

MG

See Motor-Generator Set.

Micrand

Control store word.

MMR

Monitor mask register.

Modem

(ISO) A functional unit that modulates and demodulates signals. One of the functions of a modem is to enable digital data to be transmitted over analog transmission facilities. Modem is a contraction of modulator-demodulator.

Modulation

A message signal that is impressed on a carrier signal and transmitted at another signal frequency.

Module Assembly

The circuit boards in the CP. There are 13 different modules in the CP.

MOP

Micro-operator (BDP edit instruction).

MOS

Metal-oxide-semiconductor.

Motor-Generator (MG) Interface Unit

The electrical box that interfaces with the motor-generator set. Also see Motor-Generator (MG) Set.

Motor-Generator (MG) Set

A motor generator and a separate motor-generator control cabinet that converts 3-phase site utility power to 3-phase, 400-Hz power suitable for the mainframe electrical requirements. Smaller MG sets may include the MG and its MG control functions within one cabinet and be referred to as a frequency converter.

MPS

Monitor process state pointer.

MR

Maintenance register.

MSB

Most significant bit.

MSG

Message.

MSL

Maintenance software library.

Multiplexer (MUX)

Equipment that enables a site to concentrate data transmission between multiple slower-speed devices (such as, terminals and workstations) and a higher-speed channel. For example a multiplexer can concentrate data being transmitted between multiple terminals and an host computer by using a local area network.

Must

A mandatory requirement.

MUX

See Multiplexer.

N**Network Operating System (NOS)**

An operating system for the host computer. It has network capabilities for time-sharing and transmission processing in addition to local and remote batch processing. NOS controls the computation of programs submitted through remote terminals and maintains normal batch processing operations for jobs submitted locally.

Network Operating System/Virtual Environment (NOS/VE)

An operating system for the host computer. It has network capabilities for time-sharing and transmission processing in addition to local and remote batch processing. NOS/VE operates in Virtual State and controls the computation of programs submitted through remote terminals and maintains normal batch processing operations for jobs submitted locally.

NIO

See Nonconcurrent Input/Output.

Nonconcurrent Input/Output (NIO)

An input/output unit architecture that functions with NOS.

NOS

See Network Operating System.

NOS/VE

See Network Operating System/Virtual Environment.

NPA

Network performance analyzer.

NS

Negative sign toggle.

O**OCF**

On-condition flag.

OI

Options installed.

ON

Occurrence number.

Opcode

Operation code.

Optl

Optional.

OS

Operating system.

P**P/N**

Part number.

P Register

Program address register.

PAR

Parity.

PCB

Printed-circuit board. See Logic Module.

PE

Parity error.

PFA

Page frame address.

PFS

Processor fault status.

PID

Processor identifier.

PIT

Process interval timer.

PM

See Preventive Maintenance.

PMF

Performance monitoring flag.

PN

Page number.

PND

Process-not-damaged flag.

PO

Page offset.

PONR

Point of no return.

Port

The physical connection on the device interface through which data is transferred to/from the device interface. Each port is numbered (labeled) and supports a single communication line.

Power unit

Provides power to support the electrical systems (logic, environmental, and so on) of the CPU. (The IOU has its own power supply.) The power unit occupies a cabinet that attaches to the CPU.

PP

Peripheral processor.

PPM

Peripheral processor memory.

Preventive maintenance

1. (ISO) Maintenance performed specifically to prevent faults from occurring. 2. Contrast with corrective maintenance.

Primary IOU

The IOU cabinet(s) bolted to the CPU; the IOU and, if present, the IOU non-standalone expansion.

PROM

Programmable read-only memory.

PSA

Previous save area pointer.

PSF

Previous stack frame.

PSM

Page size mask.

PSWF

Page search without find.

PTA

Page table address.

PTE

Page table entry.

PTL

Page table length.

PTM

Processor test mode.

PVA

Process virtual address.

PWR

Power.

Q**Q Register**

Operand address register.

R**RAC**

Central memory reference address register.

RAE

Extended core storage reference address register.

RAM

Random-access memory.

RDS

Register/data select.

Real Time

Pertaining to the processing of data by a computer in connection with another process outside the computer according to time requirements imposed by the outside process. This term is also used to describe systems operating in conversational mode and processes that can be influenced by human intervention while they are in progress.

Real-time clock

See Real Time and Clock.

REM

Remote.

RESP

Response.

Resync

Resynchronize.

RF**RGTR**

Register.

RI

Radial interface.

RMA

Real-memory address.

RN

Ring number.

RP

Ring number indicator. //PUB

Read permission.

ROM

Read-only memory.

RS-232-C

An Electrical and Electronic Industries Association (EIA) standard that describes the interface between terminals or other data terminal equipment and modems or other data communications equipment employing a serial binary interchange.

RTA

Remote technical assistance.

RTC

See Real-Time and Clock.

RTS

Request to send.

S**SCD**

System console driver.

SCR

Silicon-controlled rectifier.

SCSI

Small computer standard interface in IOU. The system console interfaces with the IOU through SCSI.

SCT

Special characters table.

SDE

Segment descriptor table entries.

SDT

Segment descriptor table.

SECDED

Single error correction/double error detection.

Secondary IOU

The IOU cabinet(s) not bolted to the CPU; the standalone IOU and, if present, the standalone IOU expansion.

SEG

Segment.

Sexadecimal

1. (ISO) Characterized by a selection, choice or condition that has sixteen possible different values or states. 2. (ISO) Of a fixed-radix numeration system, having a radix of sixteen. 3. Synonymous with hexadecimal.

SFSA

Stack frame save area.

Short Warning (SW)

The power unit generates on SW when an emergency power shutdown is to occur in 2.5 seconds. Also see Emergency Power Shutdown.

Should

A recommendation that is advised but not required.

SIB

See Side Interconnect Board.

Side Interconnect Board (SIB)

SIBs are the printed-circuit boards that interconnect the central processor logic modules. The multilayered SIBs actually constitute the sides of the CP logic cages. CP-0 logic modules are interconnected with SIB A and SIB B, while CP-1 logic modules are interconnected with SIB C and SIB D.

SIT

System interval timer.

Site

The computer room and other building locations that may include one or more motor-generator sets and data media storage.

SLAVACK

Slave acknowledge.

SM

1. Segment map. 2. Symbol.

SMA

Standardized maintenance approach quick reference.

SN

Negative sign.

SPID

Segment page identifier.

SPM

System power monitor.

SPT

System page table.

SR

Select reset.

SRT

Subscript range table.

SS

Status summary.

STA

Segment table address.

Stack

An area in memory used as temporary storage for chaining calls during task or interrupt service routine execution. Task calls are chained on a user stack. Interrupt service routine calls are chained on a supervisor stack.

Stack Frame

The area within a stack that accommodates a single call.

Standalone IOU

The standalone IOU is an option that provides the CYBER 960/962 mainframe with a dual IOU configuration. The standalone IOU is installed on an island separate from the mainframe, but is linked to the CYBER 960/962 CPU with 50-ft cables. Up to ten peripheral processors (PPs) and ten channels reside in the standalone IOU cabinet.

Standalone IOU Expansion

A standalone IOU expansion product can be added to the standalone IOU, doubling the PP and channel capability of the standalone IOU configuration. The standalone IOU expansion and the IOU expansion differ only in their physical location relative to the mainframe.

STL

Segment table length.

SV

Specification value.

SVA

System virtual address.

SW

See Short Warning.

System Console

The keyboard and display screen used to monitor and control the operating system.

T**T'**

T-prime register.

TE

Trap enable.

TED

Trap-enable delay.

TEF

Trap-enable flip-flop.

TER

Terminate.

TM

Test mode.

TOS

Top of stack.

TP

Trap pointer or test point.

TPM

Two-port multiplexer.

U**UART**

See Universal Asynchronous Receiver/Transmitter.

UCR

User condition register.

UEL

Uncorrected error log.

UEM

Unified extended memory.

UMID

Untranslatable virtual machine identifier.

UMR

User mask register.

Universal Asynchronous Receiver/Transmitter (UART)

An LSI circuit for start/stop serial data transfer.

User Cond

User condition.

UTC

Utility channels.

UTP

Untranslatable pointer.

UVMID

Untranslatable virtual machine identifier.

V**V**

1. Valid bit. 2. Also see Volt.

Variable transformer

An iron-core autotransformer. The output voltage of which can be varied continuously over a range from zero to maximum.

VC

Search control code.

VL

Segment validation.

VMCL

Virtual machine capability list.

VMID

Virtual machine identifier.

Volt (V)

A measure of the work needed to move an electric charge.

W**WDC**

See World Distribution Center.

World Distribution Center (WDC)

Control Data's ordering and distribution center for spare hardware parts, software revision packages, and the documentation produced to support its product lines.

WP

Write access control (segment descriptor field).

WR

Write/read.

X

X Register

Operand register.

XP

Execute access control.

Z

ZF

Zero field toggle.

ZFI

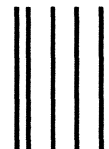
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